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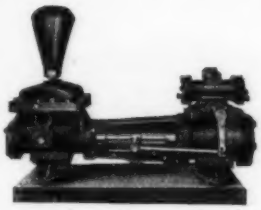

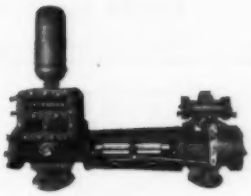

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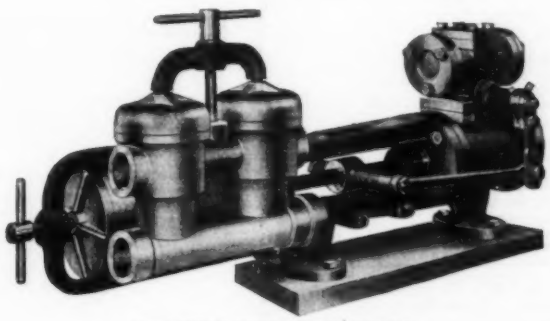

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See Jour. Dairy Sci., Jan. 21, 1921, page 32

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THE IDENTIFICATION OF THE BOVINE BY MEANS OF NOSE-PRINTS[1]

W. E. PETERSEN

Division of Dairy Husbandry, University of Minnesota, St. Paul, Minnesota

The various breed associations have always been confronted with a serious problem in the proper identification of animals for registration and of animals on official test. To guard against the possibility of substitution, the broken colored breeds (Guernseys, Holsteins and Ayrshires) require that a sketch of the color markings accompany the application for registry and that the actual markings of the animal on official test be compared by the test supervisor with the sketch on the registration certificate. This has been fairly successful but sometimes, due to the lack of drawing ability on part of breeders, the sketches in case of difficult markings do not agree with the markings on the animal. This frequently causes trouble when animals are sold or are on official test.

With the solid colored breeds, or breeds where a large number of individuals are of solid color, the present means of identification is even less satisfactory. Of these the Brown Swiss, Red Poll and Milking Shorthorn breed associations require no artificial markings while the Jerseys[2] require that each animal on test bear a tattoo mark in the ear. It is self evident that some natural distinguishing mark is necessary for positive identification as artificial marks, no matter how permanent they may be, can be applied in duplicate to different animals with which substitution can be practiced.

Under the present system for the identification of cows on official test, the word of the supervisor must be taken that he

[1] Published with the approval of the Director as Paper No. 328, Journal Series, Minnesota Experiment Station.

[2] The Jerseys also require the color of body, tongue and switch but according to T. J. Hooper of Kentucky, 66 per cent of Jerseys answer to the description: solid color, black tongue and black switch, so that such description does not positively identify.

has (in case of the broken colored animals) compared the color markings of the animal on test with the sketch on the registration certificate, and in case of the Jerseys, that he has examined the tattoo in the ear. In case of the other solid colored breeds, the owners word as to the identity of the animal must be taken.

It is with this problem in view that study was made of the practicability of the nose-print as means of identification. The work was started in October, 1921, from a suggestion of O. H. Baker of the American Jersey Cattle Club that the nose pattern might solve the identification problem if a satisfactory means could be devised of transferring the same to paper.

NO TWO ANIMALS HAVE BEEN FOUND WITH THE SAME DESIGN

Since October the nose-prints of more than 350 animals have been taken and carefully studied. No two have been found to be alike, or near enough alike but what they could easily be identified as being prints from different animals. For the purpose of study the prints were grouped into different types which are now being given further study. The basis for this grouping is the design formed by the lines starting from the center of the nose. According to this system, six distinct types have been worked out of which three are represented by figures 1, 3 and 5.

METHOD OF TAKING NOSE-PRINTS

The taking of the nose-prints has been found to be simple and easy. One man can easily take the print, when the animal is in a stanchion, by holding its head under one arm and taking the print with the free hand. Due to the fact that the bovine perspires freely through the pores of the nose, it is necessary to wipe the nose dry before applying the ink. For this purpose flannel cloth is used. The ink is then quickly applied by means of a stamping pad by either rubbing the pad back and forth or pressing directly against the nose. The print is then taken on the paper attached to a small board by pressing firmly against

the inked nose, beginning with the lower edge of the paper at the base of the upper lip and rolling toward the face.

In order to get clear prints the ink must be applied and the print taken quickly after the nose has been wiped dry as the moisture comes out rapidly from the pores. This causes the ink to run, filling up the grooves of the nose, and produces a smeared print.

The design is formed by the subcutaneous facial-nacial glands causing more or less pronounced elevations forming the irregular lines in form of grooves between these elevations. On some animals the elevations are less pronounced than on others, in which case the nose may be termed comparatively smooth. With "smooth" noses care must be taken not to press the ink pad too hard against the nose as such will fill up the groove with ink and the print will be smeared.

MIMEOGRAPH NEWS-PRINT PAPER GIVES BEST RESULTS

In tests with various papers mimeograph paper and newsprint gave the best results due to their superior absorbing qualities. Trials with smooth finish papers proved that they are unsatisfactory, producing smeared or badly blurred prints. Yellow copy paper takes the ink very well but the pigment of the paper distracts from the cleancutness of the print, making it particularly unsatisfactory for photographic work.

Ordinary letterhead size paper cut into sheets $8\frac{1}{2}$ inches by $5\frac{1}{2}$ inches was found to be a convenient size to use. This gives ample room for two prints side by side and space for the necessary data at the top which consists of name of cow, name of owner and date. The blanks in use were made by a mimeograph, printing one set for each nose print to be taken or four on one letterhead size sheet.

A convenient way of handling the print paper is to attach, by means of a clip, a dozen or more of the above described blanks to a board $\frac{1}{4}$ inch thick and $8\frac{1}{2}$ inches long by $5\frac{1}{2}$ inches wide. After one set of prints is taken the sheet is torn off and a clean sheet exposed for the next print.

TESTS WITH INKS

Various inks were tried of which black stamping pad ink proved the most satisfactory with black printers ink and mimeograph ink close seconds. The chief objection to the latter two is the difficulty of getting a sufficient amount of ink into the pad to last for a large enough number of animals. Ordinary writing inks did not prove satisfactory due to their tendencies to run after applied to the nose. Blue and red printer's and stamping pad inks did not offer the contrast on the paper that the black inks did, and are not satisfactory for photographic work.

METHOD OF IDENTIFYING PRINTS

It is not necessary to have a perfect print in order to be able to positively identify it as being the same or different from another print. It is only necessary to have the details clear on a portion of the print. The first move in comparing two prints is to ascertain whether or not they are of the same type. Figures 1 and 2 are easily identified as being of the same type, straight lines emanating on either side of a central and perpendicular line of the prints and going outward and upward at about a 45 degree angle forming elongate figures. To positively identify figures 1 and 2 as being prints of the same animal, a small area (encircled) in the same region on the two prints is selected for detailed comparison. It is easily seen that the details within the circles in figures 1 and 2 coincide and that therefore they are two prints of the same animal. In the same manner figures 3 and 4 can be identified as the same animal, likewise figures 5 and 6.

Figures 1 and 3 can also be used to study type of nose-prints. In contrast to the description of figure 1 above, the lower lines of figure 3 radiate from a central point at the base of the print and branch forming irregular figures while the top lines are more or less horizontal. Figures 5 and 6 be can identified as a third type with the lower lines radiating from a central point at the base of the print as in figures 3 and 4 but do not branch and form rather regular elongate figures instead of irregular figures.

FIG. 1. NOSE-PRINT OF JERSEY COW HERD NO. 124 OWNED BY UNIVERSITY OF MINNESOTA

Print taken October, 1921

FIG. 2. NOSE-PRINT OF JERSEY COW HERD NO. 124 OWNED BY UNIVERSITY OF MINNESOTA

Print taken November, 1921. Easily identified as being the same as figure 1

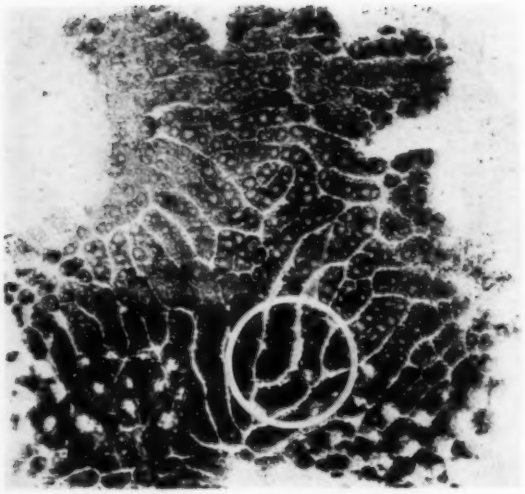

FIG. 3. NOSE-PRINT OF JERSEY COW HERD NO. 113 OWNED BY UNIVERSITY OF MINNESOTA

Print taken October, 1921

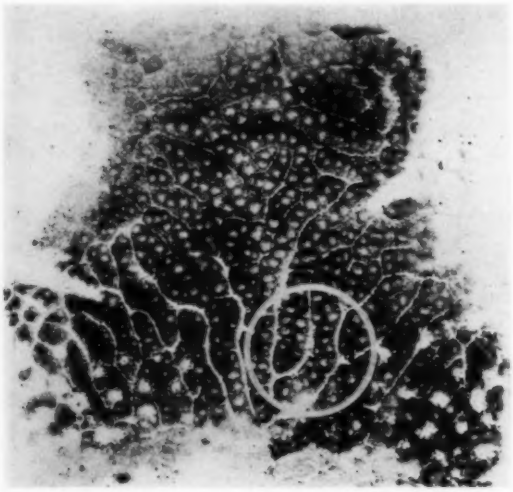

FIG. 4. NOSE-PRINT OF JERSEY COW HERD NO. 113 OWNED BY UNIVERSITY OF MINNESOTA

Print taken November, 1921. Easily identified as being the same as figure 3

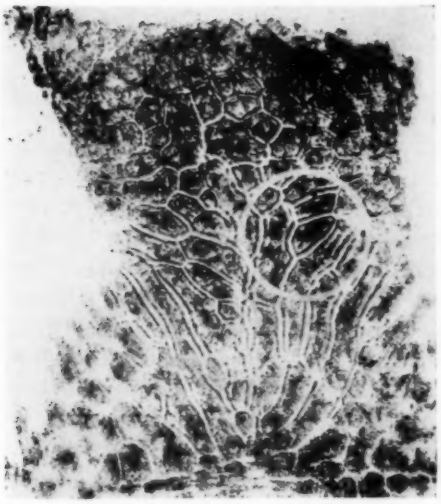

FIG. 5. NOSE-PRINT OF JERSEY COW HERD NO. 107 OWNED BY UNIVERSITY OF MINNESOTA

Print taken October, 1921

FIG. 6. NOSE-PRINT OF JERSEY COW HERD NO. 107 OWNED BY UNIVERSITY OF MINNESOTA

Print taken November, 1921. Easily identified as being the same as figure 5. These cuts illustrate means of identifying prints. Only small portion of each print need be taken into consideration as shown by circles.

DOES PATTERN CHANGE WITH THE AGE OF THE ANIMAL?

Unless the pattern remains the same throughout the life of the animal the nose-print would have little practical use. To ascertain whether or not there is any change in the pattern as the animal grows older, prints have been taken monthly, commencing in October, for five successive months of five calves in the University farm herd. These calves ranged in ages (in October) from seven weeks to twelve months; therefore the prints taken for this purpose cover a span of from seven weeks to seventeen months. A careful study of these prints reveals that there is an enlargement of the nose but no change of the type or pattern.

Prints taken monthly of a large number of older animals for five consecutive months show no changes in type or pattern. From these observations as well as from the well established fact that the pattern of the human finger-print remains the same from infancy throughout life, it is reasonable to believe that the nose pattern of the bovine likewise remains constant throughout life.

PRACTICABILITY OF THE NOSE-PRINT AS A MEANS OF IDENTIFYING COWS ON OFFICIAL TEST

To give the nose-print system a practical test in relation to its use in connection with official testing prints have been taken by different official test supervisors of cows on test in various Jersey herds. A print of each cow on test in these herds was forwarded attached to the official test report sent to the American Jersey Cattle Club. None of these supervisors had seen a print taken, all instructions as to the method of taking the prints being given them by letter. The fact that all prints sent in were good proved that the method of taking nose-prints is simple enough. Reports from O. H. Baker, chief of the register of merit department of the American Jersey Cattle Club state that the prints sent in so far were very satisfactory. Prints have now accompanied the official test reports of all Jerseys on test in the University farm herd for four successive months and in eight other Jersey herds for from one to three months.

The owner of a Jersey herd reported that the supervisor had interchanged the names of two cows in making his official report for December. The supervisor when questioned about this said that it might be possible as both cows answered the same description but that he was certain that the report was correct as to the nose-print attached. As this was the first month of test the reports together with the nose-prints were held until the January reports were sent in, also with nose-prints attached, when a comparison of the two prints showed that there had been an interchange of names in the December reports. Had not the nose-prints accompanied the reports it would have been necessary to send the supervisor back to positively identify these animals.

OTHER POSSIBLE USES

In case of death of a solid colored, registered animal there is no means of guarding against the substitution of another solid colored animal in its place. If a nose-print accompanied the application for registration and that print is affixed to the registration certificate then substitution cannot be practiced without being detected.

It also has possibilities in connection with the writing of livestock insurance. Livestock insurance companies report that they are at times called upon to pay claims where they suspect that a dead animal which was not insured had been substituted for another one in the same herd answering the same description and which was insured. The nose-print will afford a means of positive identification in such cases.

SUMMARY

More work must be done on some phases of the nose-print as a means of identification. The work done so far may be summarized as follows:

1. No two animals have identical pattern and therefore a nose-print will enable positive identification.
2. The taking of nose-prints is simple enough to be practical.

3. It is possible to identify prints as being of the same or different animal even if they are not perfect.

4. The pattern remains the same throughout life.

5. It is practical for the identification of cows on official test and may prove valuable in connection with the registration of all solid color cattle.

6. It affords a positive means of identification when claim for loss is made under livestock insurance policies.

IS A PRELIMINARY DRY MILKING ESSENTIAL IN SEMI-OFFICIAL TESTS?

J. B. FITCH, R. B. BECKER AND P. C. McGILLIARD

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The Kansas Agricultural Experiment Station rules governing Advanced Registry and Register of Merit testing require a so-called "dry milking" preliminary to the two day test. This dry milking is required in the breed association rules for Holsteins (9) and Guernseys (2), and in most cases for the Ayrshires (6), but until recently was not required by the American Jersey Cattle Club rules (3).

Very little experimental evidence concerning the influence of the preliminary milking seems to be available. Woodward and North (12) found that leaving strippings in the udder apparently increased milk production. No check period was included in the experiment, however, upon which to base comparisons. Eleven cows were included, some being used twice, making a total of 19 individual tests. From one-fourth to one-eighth of the milk was left in the udder on the evening of the second day. The results are shown in table 1.

It will be seen that leaving milk in the udders appreciably increased the milk and fat on the following day. Part of this may have been due to the residual effect of the milk which remained in the udders.

Work by Anderson (5) showed a wide variation in the fat production of consecutive milkings.

The recently published work of Regan and Mead (11) indicated that leaving one-half the milk from a previous milking in the udder caused an increase in milk and fat production, and also caused a larger percentage of butterfat in the milk during the following two days. This investigation was conducted with 4 cows, and included 7 experimental periods.

Since the dairy cattle breed associations depend largely upon two-day official tests as a basis for computing fat production in the Advanced Registry, and also depend upon the official two-day milk yield (2, 4, 7, 10) when computing abnormal or irregular milk reports (by the graph system), it is important to investigate the factors which may influence the two-day production of milk, butterfat, and the percentage of butterfat in the milk.

TABLE 1

Effect of leaving milk in the udder, on the production of milk and butterfat, Nebraska Agricultural Experiment Station

DAY	MILK	FAT	FAT
	pounds	*per cent*	*pounds*
Second	369.6	4.681	17.301
Third	419.3	4.963	20.809
Fourth	396.5	4.852	19.238
Fifth	395.7	5.112	20.230

EXPERIMENTAL METHODS

A number of factors that may influence two-day and seven-day tests are being investigated at the Kansas Station, but the present article deals with the influence of the preliminary milking only.

In this study, animals of the four dairy breeds in the College dairy herd were used. High producing and low producing cows from each breed were selected. These included 11 Holsteins, 9 Ayrshires, 8 Jerseys and 8 Guernseys, making a total of 40 trials with 36 different cows. The total of 40 trials on 36 individuals included observations on 792 milkings, 440 milkings being used to compute the effects of leaving strippings in the udders.

Practically all of the cows were on Advanced Registry test, and the reports of the normal periods were forwarded to the respective breed associations, as the official report for the month.

The junior authors were present at each milking and feeding time throughout the investigation, to maintain regularity in hours and amounts of feed. Records were kept of weights of all

milk produced. Weather conditions were noted each day, and special notation made of weather changes.

The investigation included 5 separate nine-day experiments or trials at different seasons of the year, as outlined in table 2.

Each nine-day experiment was divided into five periods, as follows:

1. Two-day observation. A dry milking was taken on the evening of the second day.

2. Two-day normal official test conducted according to the rules of the American Dairy Science Association (1) for the conduct of official tests.

TABLE 2

Experimental periods, number of milkings per day, and animals used in investigations to determine the effect of dry milking on milk and butterfat production

EXPERIMENT	TIME (INCLUSIVE)	NUMBER OF MILKINGS DAILY	BREED AND NUMBER OF ANIMALS
1	December 7 to 15, 1920	2	4 Holstein, 4 Jersey
2	April 12 to 20, 1921	3	4 Guernsey, 4 Ayrshire
3	August 15 to 23, 1921	2	7 Holstein
4	September 27 to October 5, 1921	2	8 Jerseys
5	November 27 to December 5, 1921	2	5 Guernsey, 4 Jersey

3. One-day interval, at the last milking of which one-fourth of the milk as nearly as could be estimated, was left in the udders, an equal amount being left in each quarter, as nearly as possible. The quantity was estimated by milking out an amount equal to three-quarters of the average of the four previous corresponding milkings. Milkings on this day were weighed but not sampled.

4. Abnormal period. Two-day official test conducted according to the rules of the American Dairy Science Association, except that the dry milking was omitted.

5. Two-day observation period, during which the milk was weighed but not sampled.

EXPERIMENTAL RESULTS

Each experiment is reported separately in tables 3 to 8, inclusive, followed by a summary (table 9, 10, and 11) in which the total production is tabulated according to period and breed. Some of the results are presented graphically in figures 1, 2, and 3.

TABLE 3

Effect of dry milking in first experiment. December 7 to 15, 1920

BREED AND NUMBER OF ANIMAL		PRELIMINARY PERIOD	NORMAL PERIOD	FIFTH DAY	ABNORMAL PERIOD	OBSERVATION PERIOD
Holstein 89	Milk, pounds	30.6	29.4	13.4	33.7	31.8
	Fat, per cent		3.885		3.809	
	Fat, pounds		1.1422		1.2838	
Holstein 53	Milk, pounds	33.1	34.4	15.6	33.8	32.1
	Fat, per cent		4.194		4.445	
	Fat, pounds		1.4429		1.5024	
Holstein 112	Milk, pounds	28.5	25.9	11.1	27.4	27.7
	Fat, per cent		2.942		2.924	
	Fat, pounds		0.7621		0.8011	
Holstein 104	Milk, pounds	44.5	44.3	19.8	46.4	45.2
	Fat, per cent		3.509		3.672	
	Fat, pounds		1.5547		1.7037	
Jersey 302	Milk, pounds	34.2	36.0	15.6	38.1	35.9
	Fat, per cent		6.261		6.523	
	Fat, pounds		2.2540		2.4854	
Jersey 304	Milk, pounds	24.4	25.6	11.3	24.0	22.1
	Fat, per cent		4.064		4.273	
	Fat, pounds		1.0403		1.0256	
Jersey 311	Milk, pounds	40.3	43.3	19.2	45.5	43.5
	Fat, per cent		5.467		5.695	
	Fat, pounds		2.3671		2.5913	
Jersey 316	Milk, pounds	19.8	19.9	9.1	21.2	19.1
	Fat, per cent		5.726		5.721	
	Fat, pounds		1.1395		1.2128	
Total	Milk, pounds	255.4	258.8		270.1	257.4
	Fat, per cent		4.522		4.667	
	Fat, pounds		11.7028		12.6061	

Cows milked twice daily.

Weather conditions had no apparent influence, except in the fourth period of the fifth experiment, and will not be discussed in detail. At this time, an extreme drop in temperature ac-

TABLE 4

Effect of dry milking in second experiment. April 12 to 20, 1921

BREED AND NUMBER OF ANIMAL		PRELIMINARY PERIOD	NORMAL PERIOD	FIFTH DAY	ABNORMAL PERIOD	OBSERVATION PERIOD
Guernsey 429	Milk, pounds	29.7	29.1	14.0	29.9	28.3
	Fat, per cent		4.925		4.830	
	Fat, pounds		1.4332		1.4441	
Guernsey 426	Milk, pounds	45.4	44.0	20.6	45.1	42.4
	Fat, per cent		4.542		4.600	
	Fat, pounds		1.9986		2.0748	
Guernsey 417	Milk, pounds	81.1	81.4	37.7	79.1	76.2
	Fat, per cent		3.575		3.375	
	Fat, pounds		2.9104		2.6696	
Guernsey 416	Milk, pounds	36.7	32.2	14.6	36.3	33.6
	Fat, per cent		5.794		5.652	
	Fat, pounds		1.8658		2.0517	
Ayrshire 232	Milk, pounds	62.8	62.1	28.4	61.3	59.2
	Fat, per cent		4.309		3.861	
	Fat, pounds		2.6761		2.3666	
Ayrshire 209	Milk, pounds	66.0	70.8	32.4	78.5	72.9
	Fat, per cent		3.668		4.010	
	Fat, pounds		2.5972		3.1480	
Ayrshire 207	Milk, pounds	70.9	66.1	32.7	69.3	66.6
	Fat, per cent		3.161		3.402	
	Fat, pounds		2.0897		2.3574	
Ayrshire 212	Milk, pounds	84.6	79.9	37.4	85.2	83.5
	Fat, per cent		3.127		3.535	
	Fat, pounds		2.4986		3.0117	
Total	Milk, pounds	477.2	465.6		484.7	462.7
	Fat, per cent		3.881		3.945	
	Fat, pounds		18.0696		19.1239	

Cows milked three times daily.

companied by a high wind, caused a shrink of 1.2 per cent in milk flow of the entire herd of 71 cows, including the 9 cows on experiment. This probably affected the experimental results as mentioned later.

TABLE 5

Effect of dry milking in third experiment. August 15 to 23, 1921

BREED AND NUMBER OF ANIMAL		PRELIMINARY PERIOD	NORMAL PERIOD	FIFTH DAY	ABNORMAL PERIOD	OBSERVATION PERIOD
Holstein 113	Milk, pounds	24.3	26.7	11.1	29.7	24.8
	Fat, per cent		4.199		4.334	
	Fat, pounds		1.1212		1.2871	
Holstein 102	Milk, pounds	74.7	74.2	31.8	69.8	72.9
	Fat, per cent		3.472		3.549	
	Fat, pounds		2.5759		2.4774	
Holstein 127	Milk, pounds	18.7	18.8	8.1	18.7	17.9
	Fat, per cent		4.390		4.606	
	Fat, pounds		0.8252		0.8613	
Holstein 121	Milk, pounds	46.0	44.3	19.9	43.1	44.2
	Fat, per cent		3.666		3.640	
	Fat, pounds		1.6239		1.5687	
Holstein 110	Milk, pounds	38.8	38.6	17.1	40.3	37.0
	Fat, per cent		3.338		3.254	
	Fat, pounds		1.2884		1.3147	
Holstein 106	Milk, pounds	32.7	32.7	15.6	35.7	32.7
	Fat, per cent		3.470		3.498	
	Fat, pounds		1.1347		1.2489	
Holstein 129	Milk, pounds	61.1	62.7	27.0	63.8	56.6
	Fat, per cent		3.164		3.202	
	Fat, pounds		1.9837		2.0426	
Total	Milk, pounds	296.3	298.0		301.1	286.1
	Fat, per cent		3.541		3.587	
	Fat, pounds		10.5530		10.8007	

Cows milked twice daily.

A summary of the results (table 8) shows a total increase of 48.9 pounds of milk and approximately 3.6 pounds of butterfat for the two-day period, as a result of leaving milk in the udder

on the day preceding the abnormal period. The percentage of butterfat was increased from 4.035 to 4.139.

Expressed on a percentage basis, the average increase is 3.13 per cent in milk production, 2.58 per cent in percentage of butterfat, and 5.82 per cent in production of butterfat.

TABLE 6

Effect of dry milking in fourth experiment. September 27 to October 5, 1921

BREED AND NUMBER OF ANIMAL		PRELIMINARY PERIOD	NORMAL PERIOD	FIFTH DAY	ABNORMAL PERIOD	OBSERVATION PERIOD
Ayrshire 212	Milk, pounds	20.7	19.8	9.1	18.4	18.4
	Fat, per cent		3.833		3.863	
	Fat, pounds		0.7590		0.7107	
Ayshire 207	Milk, pounds	16.4	15.6	6.8	16.9	14.7
	Fat, per cent		3.518		3.517	
	Fat, pounds		0.5488		0.5943	
Ayrshire 209	Milk, pounds	32.9	33.1	14.2	35.5	33.6
	Fat, per cent		3.822		3.477	
	Fat, pounds		1.2651		1.2345	
Ayrshire 214	Milk, pounds	54.5	53.6	21.8	52.3	47.9
	Fat, per cent		3.658		3.870	
	Fat, pounds		1.9600		2.0242	
Ayrshire 237	Milk, pounds	34.1	34.7	15.9	41.8	41.7
	Fat, per cent		3.893		3.845	
	Fat, pounds		1.3508		1.6073	
Ayrshire 234	Milk, pounds	41.0	36.5	16.7	44.7	43.4
	Fat, per cent		3.448		3.774	
	Fat, pounds		1.2585		1.6872	
Ayrshire 208	Milk, pounds	43.4	40.7	18.1	42.0	38.4
	Fat, per cent		3.501		3.775	
	Fat, pounds		1.4248		1.5855	
Ayrshire 236	Milk, pounds	49.1	48.2	21.2	46.3	42.7
	Fat, per cent		3.573		3.821	
	Fat, pounds		1.7221		1.7693	
Total	Milk, pounds	292.1	282.2		297.9	280.8
	Fat, per cent		3.646		3.764	
	Fat, pounds		10.2898		11.2130	

Cows milked twice daily.

TABLE 7

Effect of dry milking in fifth experiment. November 27 to December 5, 1921

BREED AND NUMBER OF ANIMAL		PRELIMINARY PERIOD	NORMAL PERIOD	FIFTH DAY	ABNORMAL PERIOD	OBSERVATION PERIOD
Guernsey 433	Milk, pounds	29.3	30.6	14.2	31.6	32.9
	Fat, per cent		4.168		4.569	
	Fat, pounds		1.2754		1.4437	
Guernsey 408	Milk, pounds	27.3	27.0	12.6	25.4	25.8
	Fat, per cent		4.284		4.265	
	Fat, pounds		1.1567		1.0834	
Guernsey 417	Milk, pounds	31.3	31.3	14.6	32.0	29.2
	Fat, per cent		3.968		4.002	
	Fat, pounds		1.2422		1.2805	
Guernsey 414	Milk, pounds	23.9	26.7	12.5	25.9	23.2
	Fat, per cent		5.122		5.217	
	Fat, pounds		1.3676		1.3611	
Guernsey 435	Milk, pounds	25.4	26.0	11.2	24.9	24.8
	Fat, per cent		4.123		4.212	
	Fat, pounds		1.0720		1.0488	
Jersey 322	Milk, pounds	26.1	24.3	11.1	23.8	26.7
	Fat, per cent		5.702		6.078	
	Fat, pounds		1.3855		1.4466	
Jersey 323	Milk, pounds	32.0	28.7	13.6	31.1	29.6
	Fat, per cent		4.951		5.694	
	Fat, pounds		1.4209		1.7707	
Jersey 312	Milk, pounds	27.2	26.6	12.1	26.5	24.2
	Fat, per cent		5.655		5.637	
	Fat, pounds		1.5042		1.4940	
Jersey 321	Milk, pounds	22.2	22.3	9.8	22.0	21.0
	Fat, per cent		6.413		6.508	
	Fat, pounds		1.4300		1.4318	
Total	Milk, pounds	244.7	243.5		243.2	237.4
	Fat, per cent		4.868		5.082	
	Fat, pounds		11.8545		12.3606	

Cows milked twice daily.

TABLE 8

Summary of experiments to determine the effect of dry milking on yield of milk and butterfat

EXPERIMENT	NUMBER OF TRIALS		PRELIMINARY PERIOD	NORMAL PERIOD	ABNORMAL PERIOD	OBSERVATION PERIOD
First	8	Milk, pounds	255.4	258.8	270.1	257.4
		Fat, per cent		4.522	4.667	
		Fat, pounds		11.7028	12.6061	
Second	8	Milk, pounds	477.2	465.6	484.7	462.7
		Fat, per cent		3.881	3.945	
		Fat, pounds		18.0696	19.1239	
Third	7	Milk, pounds	296.3	298.0	301.1	286.1
		Fat, per cent		3.541	3.587	
		Fat, pounds		10.5530	10.8007	
Fourth	8	Milk, pounds	292.1	282.2	297.9	280.8
		Fat, per cent		3.646	3.764	
		Fat, pounds		10.2898	11.2130	
Fifth	9	Milk, pounds	244.7	243.5	243.2	237.4
		Fat, per cent		4.868	5.082	
		Fat, pounds		11.8545	12.3606	
Total	40	Milk, pounds	1,565.7	1,548.1	1,597.0	1,524.4
		Fat, per cent		4.035	4.139	
		Fat, pounds		62.4697	66.1043	

TABLE 9

Number of cows in each experiment showing an increase or a decrease; amount and per cent of increase summarized by factors

	EXPERIMENT					
	First	Second	Third	Fourth	Fifth	Total
Number of cows showing an increase in three factors	3	4	3	2	3	15
Number of cows showing an increase in two factors	4	2	2	4	2	14
Number of cows showing an increase in one factor	1	0	1	2	2	6
Number of cows showing a decrease in three factors	0	2	1	0	2	5

Actual and percentage increase

FACTORS	ACTUAL INCREASE	PERCENTAGE INCREASE
Milk, pounds	48.9	3.13
Per cent of fat	0.104	2.58
Fat, pounds	3.634	5.82

TABLE 10

Summary by breeds of the effect of dry milking on the production of milk and butterfat

BREED	NUMBER OF TRIALS		PRELIMINARY PERIOD	NORMAL PERIOD	ABNORMAL PERIOD	OBSERVATION PERIOD
Ayrshire	12	Milk, pounds	576.4	561.1	592.5	563.0
		Fat, per cent		3.591	3.729	
		Fat, pounds		20.1514	22.0967	
Guernsey	9	Milk, pounds	330.1	328.3	330.2	316.4
		Fat, per cent		4.362	4.378	
		Fat, pounds		14.3219	14.4577	
Holstein	11	Milk, pounds	433.0	432.0	442.4	422.9
		Fat, per cent		3.577	3.637	
		Fat, pounds		15.4549	16.0917	
Jersey	8	Milk, pounds	226.2	226.7	232.2	222.1
		Fat, per cent		5.576	5.796	
		Fat, pounds		12.5415	13.4582	
Total	40	Milk, pounds	1,565.7	1,548.1	1,597.3	1,524.4
		Fat, per cent		4.035	4.139	
		Fat, pounds		62.4697	66.1043	

TABLE 11

Number of animals in each breed showing an increase or a decrease in each of the three factors

FACTORS		AYRSHIRE	GUERNSEY	HOLSTEIN	JERSEY	TOTAL
Milk	Increase	8	5	7	4	24
	Decrease	4	4	4	4	16
Per cent of fat	Increase	8	5	7	6	26
	Decrease	4	4	4	2	14
Fat	Increase	9	5	9	6	29
	Decrease	3	4	2	2	11
Total	Increase	25	15	23	16	79
	Decrease	11	12	10	8	41

The average for each individual experiment shows an increase in the production of butterfat and percentage of butterfat, and also in the production of milk, except in the fifth experiment when the production of milk remained practically the same. Failure to record a gain in this particular case may have been due to the marked change in the weather previously mentioned which apparently caused a decrease of 1.2 per cent in milk production of the entire College herd.

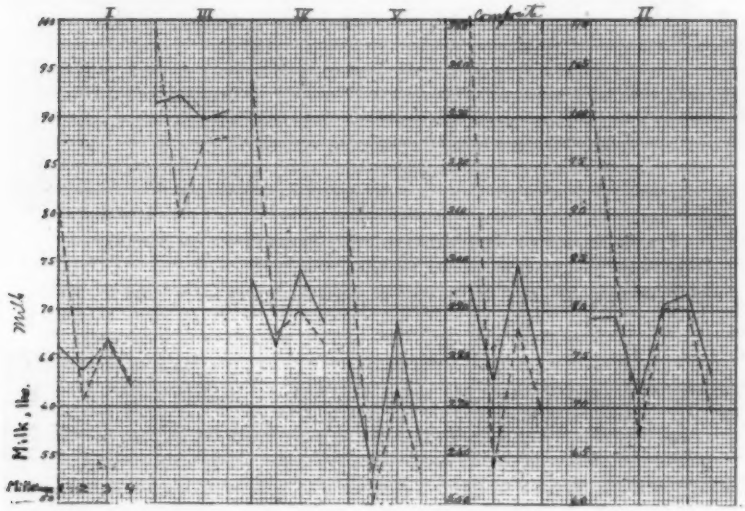

FIG. 1. EFFECT OF DRY MILKING ON MILK PRODUCTION
Normal period preceded by dry milking, ————.
Abnormal period; milk left in udder preceding this period, ————.

As indicated in figure 1, the greatest effect on milk yield appears to have been on the first and second milkings following the treatment. The effect on butterfat production extended over a longer period, and the percentage of butterfat over a still longer period. (Figs. 2 and 3.) This indicates that the effect on milk flow may be a residual effect, while the fat production is temporarily stimulated giving a greater percentage of fat in the milk.

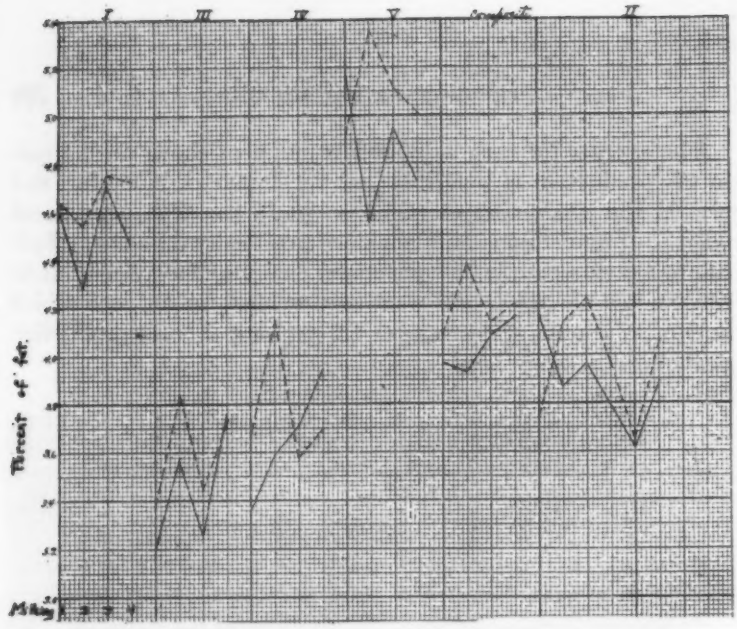

FIG. 2. EFFECT OF DRY MILKING UPON PERCENTAGE OF BUTTERFAT
Normal period preceded by dry milking, ———.
Abnormal period; milk left in udders preceding this period, ----------.

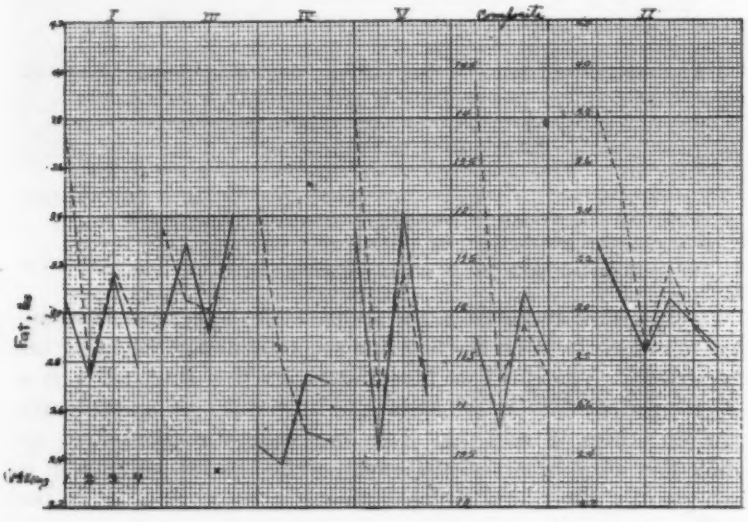

FIG. 3. EFFECT OF DRY MILKING UPON PRODUCTION OF BUTTERFAT
Normal period preceded by dry milking, ———.
Abnormal period; milk left in udder preceding this period, ----------.

Considering the data from another angle, it will be seen that leaving milk in the udder increased the test, and the production of milk and of butterfat in the case of 15 cows, while in the case of 5 cows there was a decrease in all three factors. Fourteen cows showed an increase in two factors, and 6 an increase in one factor only. This relation for each experimental period is shown in table 9.

When the data are assembled and studied (table 10), the factor of breed seems to have little influence. The ratio of increase to decrease (table 11) holds closely to 2:1 in all breeds, except with Guernseys where the ratio is 5:4.

It is of interest to determine what effect this general result has on the credit of a cow on semi-official test, where dry milking is not required. The example below, shows the effect on the credit of a cow producing 10,000 pounds of 4 per cent milk, when it has been necessary to chart by the graph method.

FACTORS	CREDIT	PERCENTAGE INCREASE	GRAPH RECORD
Milk, pounds	10,000	3.13	10,313
Per cent of fat	4.000	2.58	4.103
Fat, pounds	400.00	5.82	423.14

The credit in increased per cent of butterfat applies not only to the 10,000 pounds of milk actually produced by the cow, but also to that which is erroneously credited to her, thus having a greater effect upon the fat credit than on the milk credit.

It would seem, that if requiring a preliminary dry milking would eliminate the erroneous or dishonest credits possible to obtain through this practice, and thus semi-official records be rendered more reliable, the protection afforded to honest breeders would more than compensate for the extra expense of requiring a preliminary dry milking on all semi-official tests, with all breeds of cattle.

SUMMARY

1. It has been found possible, where a preliminary dry milking is omitted, and strippings left in the udder, to increase the yield

and percentage of butterfat in the milk during the following two days.

2. Total milk flow during the following two-day period, can be increased in this way, to conceal at least a 3 per cent padding of milk weights.

3. Breed as a factor, does not appreciably effect this influence.

4. The influence with high and low producing animals was relatively the same.

5. In view of these facts, a preliminary dry milking is essential, in order to obtain a representative "official" production during the two-day test in conducting semi-official records.

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THE CONDENSATION PROCESS OF PREPARING AN ICE CREAM MIX[1]

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The general lack of uniformity in the use of materials and the methods of manufacture is responsible for the great variation in the standards and quality of ice cream found on the market. In the present method of manufacture of commercial ice cream, whole milk, sweet cream, plain (superheated) condensed milk, sugar, gelatin, and the desired flavoring usually form the ingredients. Evaporated milk, sweetened skim condensed milk, or milk powder and butter may be substituted for the above lacteal materials. A balanced supply of the different ingredients must be kept on hand at all times, and mixed together as needed. The mix is standardized to conform to a state requirement or a desired composition. In some cases the cream or the entire mix is pasteurized; and in a few plants the mix is homogenized. This must be followed by aging to insure the desired yield.

Within the last year the use of the condensation process of preparing an ice cream mix has greatly increased. This method consists essentially of combining sugar and the different lacteal substances in the proper proportions, evaporating to the desired composition, homogenizing, and cooling. The main purpose is to utilize merely milk and butter as the basis of the milk solids and butterfat. In the present methods of manufacture, however, it is impossible to use only milk and butter because the content of milk-solids-not-fat would be insufficient.

This paper is the report of a study which was made of the methods of preparation and standardization, and the bacterio-

[1] This work was carried on under the supervision of Dr. M. J. Prucha and Dr. O. R. Overman, and with the cooperation of Dr. H. A. Ruehe, Dairy Department, University of Illinois, Urbana, Illinois.

logical factors concerned in the condensation process. Part I deals with the preparation, and part II takes up a study of the bacteria in the condensed mix.

I. PREPARATION OF THE CONDENSED MIX

Apparatus required

In the preparation of the condensed mix the essential equipment is some form of concentrating apparatus. The ordinary "vacuum condensing pan" is the most efficient for this purpose. This consists of a copper retort with a steam-jacketed bottom, steam coils inside, and some form of condenser. A large, steam-driven, vacuum pump makes possible the evaporation of water under reduced pressure, at a temperature of about 130°F., thus promoting rapidity and economy of evaporation.

The ingredients are mixed in a large open kettle, commonly known as the "forewarmer." Any vat could be utilized for the purpose. Heat may be applied by means of coils, or by introducing live steam directly into the mixture. While the latter method introduces some water, it is more rapid and serves to agitate the milk while being heated.

A Baumé hydrometer, or a Westphal balance, may be used to indicate the point of proper concentration. Either a homogenizer or a viscolizer must be utilized in order to thoroughly emulsify the fat in the mix. This prevents the rise of butterfat during storage, and increases the viscosity of the mix. An efficient means of cooling must be provided. The ordinary upright open-faced cooler answers the purpose. This type of cooler also permits the drawing off of the mix directly into clean, dry cans. The mix may be pumped into large, insulated storage tanks and held until needed.

Materials used

Fresh whole milk is the best and cheapest source of the milk-solids-not-fat. This provides a clean, fresh-milk flavor which is not destroyed in the process. Economy is obtained by con-

tracting for milk directly from the producers. Even if milk is purchased from distributors, it is still the cheapest source of milk solids. Skim milk may be used to advantage, especially if an outlet for the sweet cream is available.

Unsalted butter is necessary to add to the mix in order to supply the proper amount of butterfat. Sweet cream may be used, but the use of it tends to increase the cost of the mix, unless there is no other outlet for the sweet cream. If sweet cream is used, advantage is taken of the solids-not-fat in the cream in the process of standardizing.

Either cane or beet sugar may be used for sweetening.

Process of manufacture

General procedure. 1. Examine the milk to make sure that it is fresh, clean, and sweet. Test a representative sample of the milk and of the cream (if cream is to be used) for percentage of butterfat and total solids, calculating the solids-not-fat by difference. The percentage of butterfat in the butter should also be determined.

2. Calculate the quantity of each ingredient to use:

a. It is necessary to first decide upon the percentage composition desired in the finished mix. Butterfat, milk-solids-not-fat, sugar, gelatin, and total solids must be taken into consideration.

b. Such amounts of the different ingredients are used as will give the desired proportion of butterfat, milk-solids-not-fat, sugar, and gelatin in the finished mix. No further standardizing will then be required unless the batch is overcondensed, in which case pure water only is needed.

c. When a definite quantity of mix is desired, the amount of milk required is ascertained by multiplying the percentage of milk-solids-not-fat in the mix by the pounds of mix, and dividing by the percentage of solids-not-fat in the milk. The amount of butter required is found by multiplying the percentage of fat in the mix by the pounds of mix desired, subtracting the product of the percentage of fat in the milk times the pounds of milk, and dividing by the percentage of fat in the butter.

d. When a given quantity of milk is used, the yield of mix is found by multiplying the percentage of solids-not-fat in the milk by the pounds of milk, and dividing by the percentage of milk-solids-not-fat in the desired mix. The butter is then calculated as in (*c*) above.

e. If cream is used, the ratio method of standardizing may be conveniently applied, advantage being taken of the solids-not-fat in the cream. Special tables have been prepared for a mix of a definite composition, which greatly simplify these calculations.

3. Weigh, or carefully measure, the required quantities of each ingredient into the forewarmer. The gelatin is added after condensing, either before homogenizing, or before freezing.

4. Heat the mixture in the forewarmer to 160°–170°F. This pasteurizes the mix, facilitates the melting of the butter and the solution of the sugar, and increases the rapidity of evaporation in the condensing apparatus.

5. Remove the excess water by evaporating under a vacuum of about 24 inches, at a temperature of 130°F. The batch is "struck" when the proper reading is obtained on the Baumé hydrometer, or Westphal balance.

6. Transfer the condensed mix to a vat with an efficient agitator. If this vat is mounted on scales, the mix may be weighed. Otherwise the full yield is obtained by measuring the volume and adding the necessary water to secure the proper yield.

7. Homogenize or viscolize the warm condensed mix, under a pressure of about 2000 pounds per square inch.

8. Cool the mix as rapidly as possible to a low temperature, preferably from 40° to 45°F.

9. Store the prepared mix at as low a temperature as possible, without freezing.

10. Retest the finished condensed mix, and restandardize if necessary.

Composition of a representative mix before and after condensing (100 gallons)

MATERIALS		TEST OF MIXTURE BEFORE CONDENSING		TEST OF THE CONDENSED MIX	
	pounds		per cent		per cent
Milk, 3.5 per cent fat; 8.7 per cent solids-not-fat	1242.0	Butterfat	6.38	Butterfat	10.0
Butter, 83 per cent fat	56.0	Milk-solids-not-fat	7.66	Milk-solids-not-fat	12.0
Sugar	108.0	Sugar	7.66	Sugar	12.0
Gelatin	4.5	Gelatin	0.32	Gelatin	0.5
Total mixture	1410.5	Total solids	22.02	Total solids	34.5
Water removed	−510.5				
Finished condensed mix (100 gallons)	900.0				

The ingredients named under "materials" are placed in the forewarmer, resulting in a mixture having the composition shown in the second column. The excess water (510.5 pounds) is removed by condensing. When the desired composition is reached, the Baumé reading will be 10.3° at a temperature of 130°F. The final test is shown in the third column.

The mixture may be condensed slightly heavier than necessary, and made up to exactly 100 gallons by adding pure water. With the addition of flavoring, and gelatin if it has not been added previously, the mix is ready for freezing at any time.

Conclusions

1. A uniformly prepared ice cream mix may be made by the condensation process, using milk, butter or cream, sugar, and gelatin.

2. The condensed mix is easily standardized to a uniform composition by having the butterfat, milk-solids-not-fat, sugar, and gelatin in the proper proportion before condensing. A definite yield is thus obtained.

II. A BACTERIOLOGICAL STUDY OF THE CONDENSATION PROCESS

Since bacteria in ice cream are of importance from a sanitary as well as an economic point of view, a bacteriological study was made of the mix prepared by the condensation process.

Counts were made by the plate method, using standard lactose agar as media. An incubation period of four days at 30°C. was used. In all cases the counts given are the averages of the two plates made for each sample.

Source of bacteria

The lacteal substances used are the chief source of bacteria in the ice cream mix. Since milk and cream are ideal media for the growth and development of bacteria, it is to be expected that such products will greatly increase the bacterial count of the finished product. The sugar and gelatin are usually of minor importance, but utensils are a very prolific source of contamination.

The number of bacteria in the mix will vary according to the care that the milk products have received prior to their use, and according to the plant procedure. At the Iowa Experiment Station the number of bacteria in thirteen samples of ice cream was found to range from 130,000 to 40,850,000 per cubic centimeter (1). The United States Department of Agriculture found the average number of bacteria in 94 samples to be 37,859,907 per cubic centimeter. The maximum was 510,000,000, and the minimum 120,000 (2). The extremely high counts in ice cream are no doubt due to the fact that many manufacturers do not pasteurize their mix, nor take the proper precautions to avoid recontamination.

Efficiency of pasteurization of the condensing process

In order that ice cream may be a safe product for human consumption, and in order that the danger of souring may be reduced to a minimum, the mix should be subjected to some form of pasteurization. In the condensing process the mix is heated to 160°–170°F., in the forewarmer, and then condensed at a tem-

perature around 130°F. The efficiency of pasteurization of this process is shown by the following tabulation:

BATCH NUMBER	MIX BEFORE HEATING IN FOREWARMER	DIRECT FROM PAN		DESTRUCTION
		Actual count	Comparative count*	
				per cent
1	9,600,000	800	480	99.98
2	2,260,000	20,000	12,000	99.47
3	21,600,000	2,400	1,440	99.96
4	7,600,000	7,200	4,320	99.94
5	51,000,000	27,200	16,320	99.97
6	12,250,000	3,560	2,136	99.98
7	3,660,000	3,750	2,250	99.94

* The comparative count represents the number of bacteria per cubic centimeter that would be in the mix if the original volume had been retained, allowance being made for the decrease in volume, due to condensing. It is obtained by multiplying the actual count by 0.6.

These data show the completeness of pasteurization brought about by the heat in the forewarmer and condenser. In most cases the count of the condensed mix was quite low, the minimum being 800 and the maximum 27,200. Five of the seven batches run had a count of less than 7,500 per cubic centimeter.

The tendency of the unpasteurized mix to have extremely high counts is indicated by the number of bacteria per cubic centimeter found before heating it in the forewarmer. If ice cream is to be safely and economically produced, the mix must be subjected to some process that will greatly decrease the bacteria.

Number of bacteria at different stages of manufacture

To determine the relative importance of each step in the manufacture of the mix, counts were made of two batches after the completion of each step in the process. Care was taken to clean each utensil before it was used, by rinsing it with scalding water.

BEFORE HEATING IN FOREWARMER	DIRECT FROM PAN	DIRECT FROM HOMOGENIZER	AFTER ADDITION OF GELATIN	FROZEN ICE CREAM
9,600,000	800	1,400	1,450	2,600
2,260,000	20,000	26,200	26,250	31,000

These results indicate that after the mix is drawn from the pan the subsequent steps in the operation will result in the addition of only a very small number of bacteria if ordinary precautions are taken against recontamination. The increase after homogenizing and freezing is probably due, for the most part, to the breaking up of the bacterial clusters, which results in a higher count by the plate method.

The number of bacteria added by the gelatin will depend upon the grade of gelatin and the temperature to which it is heated. The temperature used in this experiment was 160° F., which was sufficient to kill most of the bacteria without injuring the jelling qualities of the gelatin. It may therefore be seen that with proper care there will be only a slight increase in the bacteria in the frozen ice cream over the number in the mix as it comes from the pan.

Keeping qualities of the mix

It often becomes necessary to store either the milk products or the mix for several days before freezing. It was found that condensed mix could be kept in a very good condition at a temperature of 32°–35°F. for a period of two weeks. Some was kept a month and then frozen into ice cream which contained no noticeable off-flavors.

Mix stored in 10-gallon can at 32°–35°F.

DAYS	BACTERIA PER CUBIC CENTIMETER	CONDITION
0	1,400	Very good
5	1,700	Very good
14	762,000	Good
23	42,210,000	Fair
32	188,500,000	Fair (frozen into ice cream)

As might be expected from the bacterial count, very little difference could be detected in the taste of the mix during the first two weeks of storage. It was not until the third week that a slight off-flavor began to develop. Thirty-two days after it was put into storage, the mix was frozen into ice cream, and al-

though it contained large numbers of bacteria, no off-flavor could be detected in the finished product. If the condensed mix is properly made and handled, the ice cream manufacturer should have no trouble in storing it for two weeks at a temperature of about 32° F.

Conclusions

1. From this experiment it may be concluded that it is possible to prepare an ice cream mix by the condensation process that contains a very small number of bacteria.
2. The number of bacteria in the mix as it comes from the pan approximately represents the number that will be in the frozen product, providing ordinary care is taken.
3. The mix will keep for two or three weeks when stored at a temperature of 32°–35°F.

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EFFECT OF STEAMING UPON THE GERM LIFE IN MILK CANS

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INTRODUCTION

For many years dairymen have commonly referred to milk cans which have been steamed as sterilized cans. It is, accordingly, something of a shock to learn that these steamed cans, as they reach the farm in summer, are usually teeming with germ life. Evidently there has been too much confidence in the killing effect of steam and this study is an attempt to measure the influence and limitations of steam in destroying germ life in milk cans.

For the past thirty years efforts at improving the city milk supply have been directed, largely, toward reducing its germ content and yet much of the milk as it reaches the milk plants during the summer months has a germ count of more than a million per cubic centimeter. The larger part of this germ life is the result of growth of bacteria in the milk. However, the morning's milk, which reaches the milk plant too quickly to show the influence of growth, in summer, commonly has a germ count of 50,000 to 100,000 per cubic centimeter. Previous studies (1) have shown that ordinarily at least 80 per cent of this germ life comes from the utensils in which the milk is handled, and among the utensils the cans in which the milk is transported from the farm to the milk plant are the outstanding source of bacteria.

Until recently it has been common practice to wash these cans at the milk plant, pass them over steam jets in an attempt to destroy the germ life in them, replace the covers and return them to the farm. In an increasing number of plants the cans, after being steamed, are exposed to jets of hot air with the object of drying

them. Except in rare instances this drying has not been complete, and as a result the interior of the cans as they are returned to the farm are commonly moist. At summer temperatures the presence of this moisture leads to a marked development of the germ life in the cans (2).

Data have already been presented (2) showing that when the cans containing this vast amount of germ life are properly rinsed with boiling water at the farm and used immediately, or are properly dried, they will add but few germs to the milk. However, it is manifestly undesirable that cans so heavily laden with germ life should be delivered to the producer.

Since in the milk plants steam is practically always applied by inverting the can over a jet of steam this method of application has been used in the present study.

OUTLINE OF THE STUDY

In the study there was determined the germ count of 1157 cans which had been steamed over a jet having a $\frac{1}{4}$-inch opening. These cans were of 5-, 8-, and 10-gallon capacity and were used for shipping fresh milk from thirty-four farms to two dairies. Before being steamed, the cans were well washed in water containing about 1 per cent sodium carbonate washing powder.

In this study a simple form of steam jet was used. A strong galvanized iron plate 20 inches long and 12 inches wide was fastened horizontally at the side of the washing vat, and through the center of this plate the open end of the steam pipe protruded about 4 inches above the surface. The can to be steamed was inverted on this plate and the steam blown into it. The covers of the cans were steamed separately by placing them in a metal box and inverting the box over the steam jet.

The pressure at which the steam was blown into the can was measured by a sensitive steam gage placed about 18 inches from the jet opening, between the jet and the valve which admitted the steam.

The amount of steam which is blown into a can through a given jet during the process of steaming depends upon two factors;

the length of time of steaming and the steam pressure. Thirty-six different combinations of time and pressure were tested at each of which a number of cans were steamed and then examined for bacteria.

The examination for bacteria was made by rinsing each can with one liter (approximately one quart) of sterile water; after thoroughly shaking the can, a sample was taken of this water. The germ count of the sample was determined by the plate method, using standard lactose agar and incubating the plates five days at 20°C. and two days at 37°C. The germ count of the can was calculated from the germ count of the water. These results are expressed in terms of the germs per cubic centimeter which the can would add to the milk with which it was filled.

EXPERIMENTAL RESULTS

The amount of steam blown into a can at different pressures

The amount of steam blown into a can is controlled by three factors; the size of the jet opening, the length of time of steaming, and the steam pressure at the jet.

For the gage pressure of 15 pounds or more per square inch, the amount of steam flowing into the atmosphere may be calculated from the equation, $\frac{EP}{70}$ = pounds of steam per second,[1] in which E = the area in square inches of the jet opening, P = the absolute pressure of the steam, and 70 is a constant.

For pressures below 15 pounds this formula does not hold; hence direct determinations were made by the following method: About 10 pounds of crushed ice was placed in a pail, and the steam was blown into it for a given time and at the desired pressure. The pail was weighed before and again after the steaming, and the difference in weight represented the amount of steam in pounds.

The amount of steam, at different pressures, which escapes per second when steam is blown into a can through a one-quarter inch opening is given in table 1.

[1] Kent. Mechanical Engineer's Pocket Book. 8th Edition, p. 844.

Bacteria in the cans before they were steamed

In making a study of the effect of any treatment one should of course be certain that the utensils used were sufficiently seeded with germ life to be typical examples. Since the process of determining the amount of germ life in cans removes a large portion of this germ life the information regarding the original germ content of the steamed cans was obtained by setting aside a representative portion of the washed cans to serve as checks. On each day, after the cans were washed and were ready to be steamed, a few cans were selected at random and were examined for bacteria without being steamed. In all, 191 such cans were thus examined. This was 14.2 per cent of all cans.

TABLE 1

Weight and volume of steam which escapes per second through an opening ¼ inch in diameter

STEAM PRESSURE	WEIGHT OF STEAM	VOLUME OF STEAM
pounds	*pounds*	*cubic feet**
3	0.0064	0.1664
5	0.0104	0.2704
10	0.0159	0.4134
15	0.0199	0.5177
20	0.0242	0.6292
25	0.0280	0.7280
30	0.0315	0.8190
35	0.0350	0.9100
40	0.0385	1.0010
45	0.0420	1.0920
50	0.0452	1.1752

* The volume of the steam is computed from the weight by using 26 cubic feet as the volume of 1 pound of steam.

The examination of these cans showed that the effect of these cans upon the germ count of the milk, had it been poured into them, would have been very marked. If all the cans had been filled with milk, the average increase in the germ count of this milk, due to the condition of the cans, would have been 83,000 per cubic centimeter. This makes it evident that the cans which were steamed were abundantly supplied with germ life before being steamed.

TABLE 2

Relation between the amount of steam used and the bacterial count in the steamed cans

TIME STEAMED	PRESSURE OF STEAM	AMOUNT OF STEAM	AMOUNT OF STEAM	NUMBER OF CANS	CALCULATED CONTAMINATION OF MILK DUE TO:	
					Average can	Worst can
seconds	*pounds*	*pounds*	*cubic feet*		*germs per cc.*	*germs per cc.*
0	0	0	0	191	83,186	1,289,000
3	10	0.048	1.248	21	1,574	22,048
5	5	0.052	1.352	12	44,838	276,667
5	10	0.079	2.054	24	386	2,408
3	25	0.084	2.184	26	1,166	12,884
10	5	0.104	2.704	9	12,080	45,333
20	3	0.128	3.328	58	11,923	184,210
5	25	0.140	3.640	69	46,784	1,666,667
15	5	0.156	4.056	10	5,962	32,667
10	10	0.159	4.134	65	22,528	473,684
5	35	0.175	4.550	5	246	789
30	3	0.192	4.992	55	3,781	52,368
20	5	0.208	5.408	23	603	3,667
5	45	0.210	5.460	38	248	3,777
5	50	0.226	5.876	36	100	1,770
40	3	0.256	6.656	23	20	227
25	5	0.260	6.760	26	452	8,000
10	25	0.280	7.280	29	20	447
30	5	0.312	8.112	36	269	4,667
10	30	0.315	8.190	38	129	5,789
20	10	0.318	8.268	22	799	933
50	3	0.320	8.320	30	159	2,362
10	35	0.350	9.100	25	21	270
15	20	0.363	9.438	25	121	1,867
35	5	0.364	9.464	70	1	34
60	3	0.384	9.984	35	37	449
25	10	0.398	10.348	28	24	237
20	15	0.399	10.374	24	11	138
15	25	0.420	10.920	39	8	215
30	10	0.477	12.402	73	2	45
20	20	0.484	12.584	58	6	135
25	15	0.498	12.948	51	7	152
30	20	0.726	18.876	50	2	14
30	25	0.840	21.840	6	1	1
60	25	1.680	43.680	6	1	1
120	25	3.360	87.360	6	1	1
180	25	5.040	131.040	6	1	1

Germ count of the steamed cans

A summary of the results of the examination of the 1157 steamed cans is given in table 2. The data are arranged in groups[2] according to the length of steaming and the pressure of the steam.

The volume inclosed by an 8-gallon can is practically 1 cubic foot. When the volume of steam blown into a can was equal to 2 cubic feet, the destruction of germ life became apparent. When the volume of steam amounted to approximately 5 cubic feet, the average bacterial count of the can after steaming was such that if the can had been filled with milk the bacterial count of the milk would have been increased less than 1000 per cubic centimeter. When the volume of steam was increased to about 9 cubic feet, the corresponding effect of the can on the milk was reduced to less than 100 per cubic centimeter. When the volume of steam was increased to 11 cubic feet per can, the average contamination of the milk was reduced below 10 per cubic centimeter.

Practical limits to the application of steam

It is evident from the data in table 2 that it is not practical to obtain sterile cans by the application of flowing steam. This was not accomplished when steam at a jet pressure of 25 pounds was blown into the can for three minutes.

In considering the application of these results to milk plant practice it should be remembered that with a $\frac{1}{4}$-inch opening a steam pressure of 20 pounds at the jet is practically the working limit. The use of this steam pressure for sufficient time to produce a satisfactory reduction of germ life results in the loss into the room of a considerable volume of steam. Steam is expensive and its loss in this way is not only uneconomical but this waste steam seriously interferes with the comfort of the workmen and the drying of the cans. If the pressure is increased above 20 pounds this loss is so great as to be impracticable.

[2] The detailed data from these observations will later appear in a Bulletin of the Illinois Agricultural Experiment Station.

In considering can steaming it should be remembered that the producer who brings his milk to the milk plant waits at the receiving platform until his cans are returned to him. The washing and steaming must be so handled as not to delay the receipt of the next load of milk. Where the cans are washed, steamed, and dried at the central plant there is usually an equal necessity for haste in making the cans ready for the outgoing trains. To accomplish the work in the time available it is necessary that the minimum amount of time be given to the process.

By referring to table 2 it will be seen that after steaming the cans for five seconds with 25 pounds pressure the average contamination resulting from the cans amounted to over 40,000 bacteria per cubic centimeter. Where the cans were exposed for ten seconds with a steam pressure at the jet of 30 pounds the average contamination was reduced to 130 per cubic centimeter and after fifteen seconds exposure with 20 pounds pressure the contamination was still slightly above 100 per cubic centimeter.

Evidently steaming for ten seconds at workable steam pressure will not give satisfactory results, while fifteen seconds is so long a steaming period as to delay appreciably the return of the cans.

In practical operations it is necessary to provide a margin of safety, and this margin should be above 25 per cent. Observations in many plants suggest that under present plant practice the steaming of cans is rarely continued more than five seconds, and much of it is done in a shorter time. Evidently the present treatment would have to be increased about fourfold if the contaminating influence of the cans upon the milk put into them were to be reduced with certainty below 100 germs per cubic centimeter.

The limiting factor in the speed of handling cans is the time required to wash each can. Observations of hand washing in various commercial plants suggest that cans may be washed in about five seconds. Where a single steam jet is used, as is common practice in such plants, this practically limits the steaming to a like period. It is evident that the period of steaming may be lengthened by passing the cans over a succession of steam jets without seriously delaying the handling of the cans.

It should be kept clearly in mind, however, that putting a can into satisfactory condition for immediate use by steaming is an entirely different matter from treating it so that it will be in satisfactory condition ten or twenty hours later. The data presented in earlier publications (2) show that if the steamed cans remain moist and at summer temperature the growth of germ life in the can will soon render it unfit for receiving milk, and that the possibility of holding steamed cans in satisfactory condition is closely connected with the drying of the cans. Germs do not grow on dry tin.

HOW SHOULD CANS BE HANDLED

The data given in table 2 show that after 0.45 pound of steam is applied to a can it will increase the germ count of the milk poured into it less than 100 per cubic centimeter. It has previously been shown (2) that rinsing a can with 2 quarts of boiling water will reduce the germ count to practically the same point. Calculations of the heat relations show that the condensation of 0.45 pound of steam liberates 110,000 calories while the fall of 56 degrees noted when the 2 quarts of boiling water (2) were added to a can liberates 106,000 calories. Remembering that the hot water remains in the can while the uncondensed steam is lost into the atmosphere it is seen that the application of similar amounts of heat by either method produces like results in destroying germ life. Accordingly the question of whether a can should be treated with steam or with hot water is essentially a question of convenience. Moreover, the successive steps in the proper handling of cans vary somewhat, depending upon whether the cans are being washed by hand or by machinery.

Where the cans are washed by hand it is difficult to thoroughly rinse them with boiling water. In such cases steaming them over a jet tends to destroy germ life and rinses the interior through condensation of the steam. The more thoroughly this steaming is done the larger the reduction of germ life, but the steaming over a $\frac{1}{4}$-inch jet must be continued fifteen to twenty seconds to produce, with certainty, cans which on being filled with milk will add less than 100 per cubic centimeter to the germ count of

the milk. Moreover, the cans should be thoroughly dried if they are to be held ten to twenty hours before being used. If the attempt to steam the cans is carried so far as to fill the air of the wash room with steam the proper drying of the cans is rendered doubly difficult. The drying of the can cover is even more difficult than the drying of the can, but unless the cover is also dried the labor of drying the can is largely lost.

Cans may be handled somewhat differently by machinery. The final step in the washing process should be to thoroughly rinse the cans with boiling water. It has been customary to pass the cans next over a number of steam jets and then over air jets. Where this is done the steam tends to fill the compartment where the cans are being dried and seriously interferes with the drying process. As a result such cans are rarely dried. Recent improvements in can handling machinery provide for a thorough rinsing with boiling water and minimize or omit the steaming process. The steam which was formerly applied to the cans is utilized in heating the air used in drying the cans. Observations of the cans coming from such machines make it evident that it is possible to provide cans in satisfactory condition either for immediate use, or for return to the producer.

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NEW METHOD OF BALANCING RATIONS

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With the advancement of scientific research in the field of animal nutrition the conception of a balanced ration assumes a somewhat different form.

1. Considerable emphasis is placed on proportioning the feeding stuffs according to their physical, chemical, and biological properties which affect food metabolism in the animal's body.

a. A feed is bulky or compact, coarse or fine, heavy or light, as considered under the heading, physical properties.

b. Palatability, acidity, alkalinity, toxicity, digestibility, and chemical composition of a feed, are properties of a chemical nature.

c. According to the biological effects exhibited by certain feeds on the digestive system, we find such properties as laxativeness, neutrality, costiveness or the property of causing constipation. Also the influences of "unidentified food substances" upon animal metabolism duly belong to the category of biological properties of food stuffs.

2. All feeding stuffs can be classified as follows:

- Ration
  - Class I Roughages
    - Group I. Of high protein content.
    - Group II. Of medium protein content.
    - Group III. Of low protein content.
  - Class II Concentrates
    - Group I. Nitrogenous feeds.
    - Group II. Bulky (intermediary) feeds.
    - Group III. Carbonaceous feeds.

3. For feeding milk cows the following feeding standards are widely used in this country: the modified Wolff-Lehmann or Henry and Morrison; Armsby's, and Haecker's systems. A fusion of their merits resolves itself into a "United Feeding Standard"

which facilitates the securing of all essential requirements in proper amounts.

4. Special consideration, therefore, should be given to the relation of digestible carbohydrates plus (digestible fat $\times$ 2.25) to the digestible true protein set forth in such a feeding standard. The resulting ratio to be called the true nutritive ratio (T. N. R.).

5. While applying the new method of balancing rations for milk cows the following essentials are to be borne in mind:

a. The ratio of concentrates to roughages in every day practice of feeding milk cows should be known.

b. In compounding a ration it is important to consider the relation of the carbonaceous feeds to the nitrogenous feeds in the grain mixture varying with the kind of roughage used.

c. It is helpful to know the required physical condition of the ration, so far as bulkiness is concerned.

d. An estimation of the True Nutritive Ratio (T. N. R.) according to the United Feeding Standard, is an essential guide in balancing the daily ration.

EXAMPLE

Assuming that we are asked to balance up a ration for a Jersey herd averaging 30 pounds of 4 per cent milk daily per 1000 pounds live weight. The feed sources are as follows: Mixed timothy and clover hay is available and 10 pounds of it is fed daily per 1000 pounds live weight. The silage supply is limited and only 25 pounds is fed. In addition, soaked beet-pulp is used at the rate of 2 pounds, dry, to a cow weighing 1000 pounds. Corn is raised on the farm, and a home supply of corn and cob meal is available. The cheapest sources of purchased protein are secured from cottonseed meal, linseed oil meal, and gluten feed. Wheat bran is always on hand, and dried brewer's grain can be purchased to furnish more bulk.

SOLUTION

Step I. Calculate the standard requirements and the true nutritive ratio (T. N. R.) for the case under consideration (see

appended table 1). According to the United Feeding Standard the total daily requirements are:

TABLE 1

DIGESTIBLE CARBOHYDRATES PLUS (DIGESTIBLE FAT × 2.25)	DIGESTIBLE TRUE PROTEIN	TRUE NUTRITIVE RATIO
15.842	1.970	1:8

Step II. Calculate the composition of the roughage fed daily per 1000 pounds live weight and the true nutritive ratio of the roughage.

TABLE 2

FEEDING STUFFS	POUNDS	DIGESTIBLE CARBOHYDRATES PLUS (DIGESTIBLE FAT × 2.25)	DIGESTIBLE TRUE PROTEIN	TRUE NUTRITIVE RATIO
Timothy and clover	10	4.455	0.36	
Corn silage	25	4.135	0.150	
Beet pulp, dry	2	1.309	0.014	
Total	37 cont.	9.899	0.524	1:18.8

Step III. Calculate: (a) The true nutritive ratio of the grain mixture to be compounded.

	DIGESTIBLE CARBOHYDRATES PLUS (FAT × 2.25)	DIGESTIBLE TRUE PROTEIN	TRUE NUTRITIVE RATIO
Standard requirements	15.842	1.970	
Roughage provides	9.899	0.524	
Balance	5.943	1.446	1:4.1

Answer: 1:4.1 is the T. N. R. of the grain mixture under consideration.

Step IV. Place the available feeds into groups in respect to bulkiness, digestible true protein content, and digestible carbonaceous content (see appended table 2).

Group I. Bulky feeds available in the given case are: Wheat bran and brewer's grain.

Group II. Linseed oil meal, cottonseed meal, and gluten feed are high in digestible true protein.

Group III. Corn and cob meal is high in the digestible carbonaceous content.

Step V. Assuming that the proportion of the individual feeds within each group is as follows: In group I two parts of wheat bran are taken for every part of dried brewer's grains: in group II two parts of gluten feed and one and one half parts of oil meal are taken for every part of cottonseed meal.

Calculate the composition of each group its average true nutritive ratio, and "true protein factor."[1]

TABLE 3

GROUP	PARTS	FEEDING STUFFS	DIGESTIBLE CARBONACEOUS CONTENT	DIGESTIBLE TRUE PROTEIN	TRUE PROTEIN FACTOR	AVERAGE TRUE NUTRITIVE RATIO
I	2	Wheat bran	0.968	0.216		1:3.37
	1	Dried brewer's grain	0.442	0.202		
			1.410	0.418		
	1	Bulky feeds	0.470 or 47%	0.139 or 13.9%	7.19	
II	1	C. S. meal (choice)	0.412	0.354		1:1 94
	1½	Oil meal (O. P.)	0.705	0.427		
	2	Gluten feed	1.186	0.402		
			2.303	1.183		
III	1	Nitrogenous feeds	0.511 or 51.5%	0.262 or 26.2%	3.81	1:12.63
	1	Corn and cob meal	0.720	0.057		
	1	Carbonaceous feeds	0.720 or 72%	0.057 or 5.7%	17.54	

Step VI-A. Balance the three groups of feed available so that the grain mixture will give you the desired true nutritive ratio and the amount of every feeding stuff within each group.

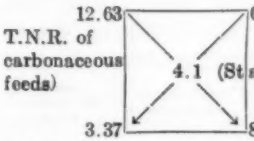
[1] The "true protein factor" is obtained by dividing 100 by the per cent of digestible true protein.

TABLE 4

	DIGESTIBLE CARBONACEOUS CONTENT	DIGESTIBLE TRUE PROTEIN	AVERAGE TRUE NUTRITIVE RATIO	TRUE PROTEIN FACTOR
	per cent	*per cent*		
Having bulky feeds containing	47.0	13.9	3.37	7.19
Having nitrogenous feeds containing	51.1	26.2	1.94	3.81
Having carbonaceous feeds containing	72.0	5.7	12.63	17.54

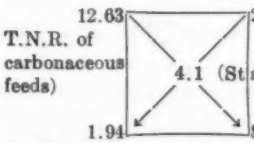
Apply Pearson's square method using the T. N. R. figures.

Thus:



0.63 (parts of carbonaceous feeds) × 17.54 equals 11.05 lbs. of carbonaceous feeds

8.53 (parts of bulky feeds) × 7.19 equals 61.33 lbs. of bulky feeds.



2.16 (parts of carbonaceous feeds) × 17.54 equals 37.88 lbs. of carbonaceous feeds.

8.53 (parts of nitrogenous feeds) × 3.81 equals 32.49 lbs. of nitrogenous feeds.

Collecting the answers we obtain the following:

1. Carbonaceous feeds 11.05 plus 37.88 equals 48.93 pounds.
2. Bulky feeds, 61.33 pounds.
3. Nitrogenous feeds, 32.49 pounds.

The smaller number is always to be substracted from the large one irrespective of position (provided you follow the arrow) in order to comply with the principle of alligation involved in the Pearson's square method.

Step VI-B. a. Since the bulky feeds are made up of three parts, namely, two parts of wheat bran and one part of dried brewer's grain.

Hence (1) 61.33 ÷ 3 equals 20.44 pounds of dried brewer's grains.
(2) 20.44 × 2 equals 40.88 pounds of wheat bran.

b. In the case of the notrogenous feeds we have 1 plus 1.5 plus 2 equals 4.5 parts,

Hence: (1) 32.49 ÷ 4.5 equals 7.22 pounds of c.s. meal (choice.)
(2) 7.22 × 1.5 equals 10.83 pounds of oil meal (O.P)
(3) 7.22 × 2 equals 13.44 pounds of gluten feed.

c. Finally the carbonaceous group of feeds is represented by 48.93 pounds of corn and cob meal.

TABLE 5

FEEDING STUFFS	AMOUNT	DIGESTIBLE CARBOHYDRATES PLUS (DIGESTIBLE FAT × 2.25)	DIGESTIBLE TRUE PROTEIN	TRUE NUTRITIVE RATIO
	pounds			
Corn and cob meal	48.93	35.229	2.789	
Gluten feed	14.44	8.562	2.902	
Oil meal (O. P.)	10.83	5.165	3.086	
C. S. meal (choice)	7.22	2.974	2.555	
Wheat bran	40.88	19.785	4.415	
Dried brewer's grain	20.44	9.034	4.128	
	142.74	80.749	19.875	1:4.06
Required T. N. R.				1:4.1

Step VII. By feeding 10.5 pounds of this grain mixture in addition to the amount of roughage alloted per 1000 pounds live-weight (see step II) a good supply of a 1:8 true nutritive ratio (T. N. R.) is insured.

I wish to express my thanks to Prof. H. P. Davis, Chairman of the Dairy Department and Prof. B. H. Thompson, Assistant Professor of Dairy Husbandry for reading the proof and for the valuable suggestions made in connection with this work.

APPENDIX

Merits of the main feeding standards used in this country

Henry and Morrison's feeding standard deals with the digestible crude protein and total digestible nutrients; Armsby's feeding standard is based upon digestible true protein and therms of net energy; and, Haecker's feeding standard considers the digestible carbohydrates and digestible fat, as well as, the digestible crude protein.

All of the enumerated feeding standards take into account the quality, as well as the quantity of the milk produced by the milk cow.

For each additional 0.1 of one per cent butterfat per pound of milk Henry and Morrison's standard requires from 0.0004 to 0.0008 pound of digestible crude protein and 0.006 pound of total digestible nutrients. Armsby's standard requires for each additional 0.1 of one per cent butterfat per pound of milk 0.0004 pound digestible *true protein* and 0.004 therm of energy. Haecker's standard assigns for each additional 0.1 of one per cent butterfat per pound of milk from 0 to 0.001 pound of digestible crude protein, from 0 to 0.01 pound of digestible carbohydrates, from 0 to 0.001 pound of digestible fat.

Illustration. Given a Jersey herd producing 30 pounds of 4 per cent milk daily per 1000 pounds of live weight. What are the daily requirements?

APPENDED TABLE 1

A 1000-pound cow producing 30 pounds of 4 per cent milk daily requires

FEEDING STANDARD	CASE	DIGESTIBLE CRUDE PROTEIN	DIGESTIBLE FAT	DIGESTIBLE CARBOHYDRATES	TOTAL DIGESTIBLE NUTRIENTS	DIGESTIBLE TRUE PROTEIN	NET ENERGY
		pounds		*pounds*	*pounds*	*pounds*	*pounds*	*therms*
Henry and Morrison's	Maintenance	0.700			7.925		
	1000 pounds, 30 pounds of 4 per cent milk	1.740 (av.) 1.53-1.95			10.380		
Total daily requirement		2.440			18.305		
Armsby's	Maintenance						
	1000 pounds, 30 pounds of 4 per cent milk					0.500 1.470	6.00 8.10
Total daily requirement						1.970	14.10
Haecker's	Maintenance	0.700	0.100	7.00			
	1000 pounds, 30 pounds of 4 per cent milk	1.620	0.630	7.20			
Total daily requirement		2.320	0.730	14.20			
United feeding standard	Maintenance		0.100	7.00		0.500	
	1000 pounds, 30 pounds of 4 per cent milk		0.630	7.20		1.470	
Total daily requirement			0.730	14.20		1.970	

$$\text{True nutritive ratio} = \frac{14.2 \text{ plus } (0.73 \times 2.25)}{1.97} = 8$$

T. N. R. = 1:8

APPENDED TABLE 2

Composition of some common feeds

NAME OF FEED*	DIGESTIBLE TRUE PROTEIN †	DIGESTIBLE CARBOHYDRATES PLUS (FAT × 2.25) ‡	TRUE NUTRITIVE RATIO	BULK	REMARKS
	per cent				
Concentrates:					
Barley grain	8.3	70.4	8.4	Light	Neutral, fairly palatable
Buckwheat middlings	20.8	52.0	2.5	Medium	Slightly constipative; poor for young stock
Corn meal	6.4	77.0	12.0	Heavy	Neutral; very palatable; widely used for feeding purposes
Corn and cob meal	5.7	72.0	12.6	Medium	Neutral; fairly palatable
Cotton seed meal (choice)	35.4	41.2	1.1	Heavy	Constipative; fair results in moderate feeding
Cocoanut meal	18.0	60.2	3.3	Heavy	Laxative; fairly palatable; can be used moderately
Cowpea meal	16.9	45.0	2.7	Heavy	Slightly laxative; good results in all feeding purposes
Dried brewer's grains	20.2	44.2	2.1	Light	Neutral; fairly palatable, used extensively
Dried beet pulp	0.7	67.0	95.7	Light	Laxative; very palatable; excellent winter succulence
Flour middlings	14.0	62.5	4.4	Heavy	Slightly constipative; poor for growing stock
Gluten feed	20.1	59.3	2.9	Medium	Neutral; fairly palatable; used for all feeding purposes
Gluten meal	28.1	53.8	1.9	Heavy	Neutral; fairly palatable; used for all feeding purposes
Ground oats	8.7	58.7	6.7	Light	Slightly laxative; very palatable; excellent for all ing purposes
Hominy feed	6.5	77.2	11.8	Medium	Neutral; fairly palatable; used considerably
Linseed oil meal (O. P.)	28.5	47.7	1.6	Heavy	Laxative; excellent for all feeding purposes

APPENDED TABLE 2—*Continued*

NAME OF FEED*	DIGESTIBLE TRUE PROTEIN †	DIGESTIBLE CARBOHYDRATES PLUS (FAT × 2.25) ‡	NUTRITIVE TRUE RATIO	BULK	REMARKS
Concentrates:	*per cent*				
Linseed oil meal (N. P.)	30.9	44.2	1.4	Heavy	
Malt sprouts	12.5	49.2	3.9	Light	Neutral; poor for growing stock
Peanut meal	16.9	38.5	2.2	Medium	Laxative; fairly palatable; good for all feeding purposes
Standard middlings	12.0	55.9	4.6	Medium	Slightly laxative; fairly palatable; good for all feeding purposes
Soy bean meal	27.3	45.1	1.7	Heavy	Laxative; good for all feeding purposes
Wheat bran	10.8	48.4	4.4	Light	Laxative; very palatable; excellent for all feeding purposes
Roughages:					
Alfalfa hay	7.1	41.0	5.7	Light	Laxative; very palatable; excellent nitrogenous roughage
Alfalfa green	1.9	11.3	5.9	Light	Laxative; very palatable; excellent roughage
Clover hay	4.9	43.3	8.8	Light	Laxative; very palatable; good nitrogenous roughage
Corn silage	0.6	15.8	26.3	Light	Laxative; very palatable; good for all feeding purposes
Millet hay	3.9	50.0	12.8	Light	Neutral; fairly palatable for ordinary purposes
Soy bean hay	8.8	41.9	4.7	Light	Neutral; fairly palatable; fair roughage for all feeding purposes
Timothy hay	2.2	45.5	20.6	Light	Constipative; poor dairy roughage
Mangels	0.1	8.0	80.0	Light	Laxative; very palatable; excellent for all feeding purposes

* Computation made from composition table of Pennsylvania Experiment Station Bulletin 142.

† Computed from Henry and Morrison, "Feeds and Feeding."

‡ Taken from Bulletin 90, Storrs Experiment Station.

STUDIES IN THE GROWTH AND NUTRITION OF DAIRY CALVES

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I. THE GESTATION PERIOD

The gestation period of the cow is generally recognized as of fairly definite length, though few reports have been made on this subject. These reports include a considerable number of animals but little study has been given to the variations which occur in the length of gestations.

RÉSUMÉ OF PREVIOUS WORK

On summarizing 764 gestation periods, Spencer (4) found that 314 of them ended 284 days or less after the date of breeding, and 310 of them 285 days or more after that time. He stated that gestations of less than 260 days' duration had ended decidedly prematurely, while those of over 300 days were very irregular though they did not affect the offspring. After studying 182 normal gestations on 20 cows, Wing (5) found the average length to be 280 days regardless of the sex of the offspring. The majority were from 274 to 287 days in length and were fairly evenly distributed throughout that period. He also noted that some cows had uniformly long and others uniformly short periods of gestation. From 1062 observations Fleming (2) found the average length of the gestation period to be 283 days.

EXPERIMENTAL WORK

The data presented here was collected from the herd on Iowa State College Dairy Farm from December, 1907, to November, 1921, inclusive. A summary of 369 gestation periods are presented. Gestation periods during which twins were carried have

not been included. In addition to the general results obtained an effort has been made to find what influence, if any, the age of the cow at the time of freshening and the season of freshening have on the length of the gestation period.

TABLE 1

Average length of gestation period

BREED	NUMBER OF COWS	NUMBER OF CALVES			AVERAGE GESTATION PERIOD		
		Male	Female	Total	Male	Female	Total
Purebreds							
					days	*days*	*days*
Ayrshire	14	15	20	35	277	279	278
Guernsey	25	42	35	77	282	281	281
Holstein	28	41	33	74	276	279	278
Jersey	31	38	35	73	280	280	280
Grades							
Ayrshire	2	2		2	282		282
Guernsey	21	22	26	48	282	282	282
Holstein	14	20	17	37	279	280	279
Jersey	10	7	12	19	279	277	278
Scrubs	4	2	2	4	287	285	286
Grades	47	51	55	106	280	280	280
Purebreds	98	136	123	259	279	280	279
All calves	149	189	180	369	279	280	280

TABLE 2

Distribution of gestation periods according to their duration

LENGTH OF GESTATION	NUMBER OF CALVES			DISTRIBUTION OF GESTATIONS		
	Male	Female	Total	Male	Female	Total
days				*per cent*	*per cent*	*per cent*
251	15	2	17	8.4	1.1	4.7
261	23	9	32	12.7	5.2	9.1
271	69	80	149	38.3	45.7	42.0
281	69	75	144	38.3	42.8	40.6
291	4	9	13	2.3	5.2	3.6

The gestation periods have been tabulated by breeds, and the scrubs separated from the grades and purebreds. The scrubs

TABLE 3

Influence of age of cow at freshening on length of gestation period

AGE OF COW	NUMBER OF CALVES			AVERAGE LENGTH OF GESTATION		
	Male	Female	Total	Male	Female	Total
years				days	days	days
1	1	2	3	285	280	281
2	44	39	83	282	279	281
3	41	32	73	280	279	280
4	26	31	57	282	279	280
5	20	20	40	285	279	282
6	11	14	25	283	280	281
7	13	12	25	282	281	282
8	12	10	22	280	282	281
9	4	6	10	282	285	284
10	3	4	7	281	285	283
11	4	3	7	284	284	284
12	4		4	281		281
13	1	2	3	291	278	282
14	1	2	3	285	282	283

TABLE 4

Influence of season of freshening on length of gestation period

MONTH OF FRESHENING	NUMBER OF CALVES			AVERAGE LENGTH OF GESTATION		
	Male	Female	Total	Male	Female	Total
				days	days	days
January	13	19	32	281	281	281
February	20	23	43	278	280	279
March	26	22	48	280	280	280
April	15	11	26	279	284	281
May	11	14	25	279	278	278
June	14	10	24	278	282	280
July	15	11	26	277	285	280
August	11	14	25	283	280	282
September	14	16	30	278	279	279
October	18	19	37	281	284	284
November	17	9	26	277	283	279
December	14	8	22	284	281	283

and grades were all used for experimental breeding work. A sex distinction was also made in the tabulation.

In order that a clearer conception of the connection between the sex of the calf and the length of gestation period may be obtained, the percentage of the calves of each sex carried through gestation periods of various lengths have been determined. Only 355 gestations could be used for this purpose and they are tabulated in groups varying in duration by ten days. The first group includes gestations of 251 to 260 days, the second group is made up of gestations of 261 to 270 days, and so on. Gestations of less than 260 days and those approaching 300 days in length must be looked on as somewhat abnormal although the calves were dropped in good healthy condition.

In determining the influence of the age of the cow on the length of the gestation period, some of the periods had to be discarded as records were not available in all cases of both the age of the cow and the length of the gestation period. As a consequence only 362 of the 369 periods are used for this purpose.

In determining the influence of the season of freshening on the length of the gestation period, the records were tabulated by months. It was again necessary to delete a few records so that only 364 are available.

DISCUSSION OF RESULTS

When all the records available for this study are taken into consideration, it is found that the average length of the gestation period for dairy cows is 280 days. There were no significant variations so far as the breed of the cows was concerned.

It has frequently been stated and is a very common belief that the periods of gestation during which bull calves are carried are longer than those for heifer calves. The average of all the records studied here, however, shows an average gestation period of 280 days for both bull and heifer calves. On studying the distribution of the gestation periods of various lengths, it is found that 38.3 per cent of the male calves were dropped after a period of 271 to 280 days in utero while an equal percentage of them were dropped after 281 to 290 days in utero. The

corresponding figures for the heifers are 45.7 per cent and 42.8 per cent. This shows that the gestation periods are more closely grouped, so far as duration is concerned, in the case of heifer calves than in the case of bull calves. When the extremes are considered, it is found that 21.1 per cent of the bull and 6.3 per cent of the heifer calves are carried in utero for 270 days or less while 2.3 per cent of the bull and 5.2 per cent of the heifer calves are carried for 291 days or more. This does not indicate any greater length of the gestation period in the case of bull calves.

The age of the cow at the time of freshening and the season of freshening are factors which also appeared to have no influence on the length of the period of gestation.

SUMMARY

From the data studied here it was found that:

1. The average length of the gestation period in dairy cows was 280 days.
2. This was not affected by the breed of the cows.
3. The sex of the calf had no apparent influence on the length of the gestation period.
4. Male and female calves were dropped in practically equal numbers.
5. On the average 82.6 per cent of the calves were carried in utero for a period of 271 to 290 days.
6. The age of the cow at the time of freshening was without influence on the duration of the gestation period.
7. The length of the gestation period was not influenced by the season of freshening.

II. THE BIRTH WEIGHTS OF CALVES

In spite of the fact that many feeding trials have been conducted with dairy calves, few reports are to be found regarding the birth weights of calves and the factors that influence them. The few reports available however contain data on several hundred animals and so are of considerable value, except in the case of some breeds.

RÉSUMÉ OF PREVIOUS WORK

The work so far reported on this subject can be very easily summarized as Henry and Morrison (3) reported the work available from all experiment stations while later Eckles (1) published data in similar form.

Eckles (1) noted that the first and second calves of heifers were somewhat heavier than those born at later ages but that small calves were often delivered after short gestation periods and large calves after long periods, but between these extremes

TABLE 5

Reported average birth weights of dairy calves

BREED	NUMBER OF CALVES	AVERAGE WEIGHT			RELATION OF WEIGHT OF CALF TO WEIGHT OF DAM
		Males	Females	Total	
Henry and Morrison (2)					
		pounds	*pounds*	*pounds*	*per cent*
Ayrshire	34	77	74	76	7.8
Guernsey	57	75	68	71	7.1
Holstein	104	94	85	89	7.7
Jersey	119	58	49	55	6.1
Eckles (1)					
Ayrshire	53	73	65	69	6.9
Holstein	154	93	88	90	8.0
Jersey	196	58	53	55	6.5

there was no evidence of correlation between the weight of the calf and the length of the gestation period.

EXPERIMENTAL WORK

A digest has been made of the herd records kept at the Dairy Farm of Iowa State College from December, 1907, to November, 1921, inclusive and the work reported here includes data on 369 calves and is closely connected with the material presented in paper I of this series. Only records on single calves are included, as it was thought best to treat them alone and the number of twins was too small to really justify treatment here.

An attempt has been made to study some of the factors which might be presumed to have some influence on the birth weights of calves.

In the general summary the breeds have been kept separate, and the scrubs separated from the grades and purebreds. A sex distinction has also been made. The scrubs and grades were animals used in investigational work. A considerable

TABLE 6

Average birth weights of calves

BREED	NUMBER OF COWS	NUMBER OF CALVES			AVERAGE BIRTH WEIGHT		
		Male	Female	Total	Male	Female	Total
Purebreds							
					pounds	*pounds*	*pounds*
Ayrshire	14	15	20	35	68	65	66
Guernsey	25	42	35	77	66	61	64
Holstein	28	41	33	74	97	89	94
Jersey	31	38	35	73	55	52	54
Grades							
Ayrshire	2	2		2	60		60
Guernsey	21	22	26	48	68	63	65
Holstein	14	20	17	37	83	77	81
Jersey	10	7	12	19	55	53	54
Scrubs	4	2	2	4	67	51	59
Grades	47	51	55	106	72	65	68
Purebreds	98	136	123	259	73	66	70
All calves	149	189	180	369	72	65	69

number of grades, of the various breeds except the Ayrshire, are included. These grades vary considerably, as some of them are the result of but one cross of purebred bulls and scrub cows, while others are the result of two and three and in one case four crosses of purebred bulls.

On studying the influence of the age of the cow at the time of freshening on the birth weight of the calf, a few records had to be deleted as the age of the cow and the birth weight of the calf were not always available. Consequently, only 366 records

are available for this part of the work. The age divisions are each of one year, for example, the two-year old group includes all cows two years old but under three. Cows from one to sixteen years of age are included.

TABLE 7

Influence of age of cow at freshening on birth weight of calf

AGE OF COW	NUMBER OF CALVES			AVERAGE BIRTH WEIGHT OF CALVES		
	Male	Female	Total	Male	Female	Total
years				*pounds*	*pounds*	*pounds*
1	1	2	3	97	64	75
2	46	39	85	65	64	64
3	41	33	74	75	67	71
4	26	31	57	78	68	73
5	20	20	40	77	69	73
6	11	14	25	70	65	67
7	13	12	25	79	62	71
8	12	10	22	72	73	72
9	4	6	10	67	76	72
10	3	4	7	79	57	66
11	4	3	7	70	55	64
12	4		4	62		62
13	1	2	3	65	54	58
14	1	2	3	60	59	59
15						
16	1		1	60		60

TABLE 8

Influence of weight of cow at freshening on birth weight of calf

WEIGHT OF COW	NUMBER OF CALVES			AVERAGE BIRTH WEIGHT OF CALVES			RELATION OF WEIGHT OF CALF TO WEIGHT OF DAM
	Male	Female	Total	Male	Female	Total	
pounds				*pounds*	*pounds*	*pounds*	*per cent*
700	5	5	10	57	52	55	7.3
800	7	11	18	58	58	58	6.8
900	25	26	51	64	59	61	6.4
1000	32	26	58	72	60	66	6.3
1100	20	25	45	73	71	72	6.3
1200	14	19	33	82	72	76	6.1
1300	7	10	17	83	86	84	6.2
1400	10	8	18	103	92	98	6.8
1500	5	3	8	101	97	100	6.5

The number of cases in which the relationship of the weight of the cow at freshening to the weight of the calf at birth are more limited than in some of the other studies as in the earlier part of the period from which the records are taken the cows

TABLE 9

Influence of season of freshening on birth weight of calves

MONTH OF FRESHENING	NUMBER OF CALVES			AVERAGE BIRTH WEIGHT OF CALVES		
	Male	Female	Total	Male	Female	Total
				pounds	*pounds*	*pounds*
January	12	18	30	75	66	70
February	20	23	43	74	76	75
March	28	23	51	75	67	72
April	15	11	26	66	63	64
May	12	13	25	71	60	65
June	13	10	23	72	58	66
July	14	11	25	59	66	62
August	11	16	27	72	68	69
September	14	17	31	73	61	67
October	19	20	39	76	62	69
November	17	10	27	74	73	74
December	14	8	22	77	69	74

TABLE 10

Influence of length of gestation on birth weight of calves

LENGTH OF GESTATION	NUMBER OF CALVES			AVERAGE BIRTH WEIGHT OF CALVES		
	Male	Female	Total	Male	Female	Total
days				*pounds*	*pounds*	*pounds*
251	15	2	17	75	43	71
261	23	9	32	70	68	70
271	69	80	149	73	65	69
281	69	75	144	73	65	69
291	4	9	13	69	77	74

were not weighed regularly. Through the greater portion of the time, however, the cows were weighed weekly and the last weight before freshening was considered to be the weight of the cow at freshening. This renders 258 records available. The cows were then classified according to weight. Those weighing

700 pounds to 799 pounds were put in the 700-pound group and so on. The weights arrived at in this way were those used in determining the percentage of the live weight of the dam that the weight of the calf represented.

All the records were available for determining the influence of the season of freshening on the birth weight of the calf. These records were arranged by months.

In considering the influence of the length of the gestation period on the birth weight of the calf, the gestation periods have been taken by ten-day groups, for example, gestations of 251 to 260 days have been grouped together. Only 355 records were available for this purpose.

DISCUSSION OF RESULTS

When the purebred calves are separated out according to breeds, it is found that the Holstein calves lead in weight and are followed by the Ayreshire, Guernsey and Jersey calves. The bull calves are heavier than the heifers in each breed. The grades, with the exception of the Ayrshires which are too small in number to be of significance, approximate the purebreds in birth weight. On the average the scrub calves have the lowest birth weight and the purebreds, the highest. When all classes are grouped together, it is found that the average birth weight is 72 pounds for the bull calves, 65 pounds for the heifer calves and 69 pounds for all.

The age of the cow at the time of freshening may have some influence on the birth weight of the calf. The weights for the calves of yearlings are high, due to the fact that one bull coming in this group is well above the average in birth weight. Leaving this class out of consideration however, it would appear that there is some slight rise in the birth weights of the calves as the cows go from two to five years of age; from then on there is a tendency for the calves to be of lower birth weight.

As the cows increase in weight from an average of 750 pounds in the first group to an average of 1550 pounds in the last group the average birth weights of the calves from these cows increase.

This is true for both the males and females and the average of all. In the case of the average the increase was from 55 pounds to 100 pounds. The relation of the birth weight of the calf to the weight of the dam, when expressed as a percentage of the live weight of the dam does not follow this, however. It decreases from 7.3 per cent in the 700-pound cow group to 6.1 per cent in the 1200-pound group and then shows irregular increases among the groups of greater weight.

It cannot be said that there is any very definite variation in the weight of the calves dropped at different seasons. However it does appear that the average birth weights of the calves dropped in the months of April to October, inclusive, are lower than the weights of those dropped at other times. Within those two main periods, however, there are irregular variations from month to month.

The length of the gestation period has little influence on the birth weights of the calves. However, when the gestation is about the average in length, the calves are near the average in birth weight and as the gestation period varies from normal the birth weight of the calves appears to increase slightly.

SUMMARY

After considering the data presented here the following statements may perhaps be made.

1. The average birth weights found for the calves studied were 72 pounds for males, 65 pounds for females, and 69 pounds for all calves.

2. Of the purebred calves the Holsteins were the heaviest and they were followed by the Ayreshires, Guernseys and Jerseys.

3. The scrub calves had the lowest average birth weight and the purebreds, the highest, though the grades approximated the purebreds in weight.

4. As the cows increase in age up to five years, the average birth weight of the calves apparently increases. From then on there is an irregular decrease in the weights of the calves.

5. With an increase in the weight of the cows there is an increase in the birth weight of the calves, though this is not in

direct proportion to the increase in the weight of the cows. It is not possible to determine from the data available just how closely the increase in weight of the cows follows advancing age. The two factors are correlated to a certain extent and it is difficult to determine which one is of more importance.

6. It may be true that calves dropped from April to October, inclusive, are lighter than those dropped during the rest of the year. There are fairly wide variations in the birth weights of the calves dropped in each of those periods however.

7. The length of the gestation period has little influence on the birth weight of calves, but the more closely the gestation approaches normal in length the nearer are the birth weights to normal. As the gestations recede from normal the greater become the birth weights of the calves.

III. THE RATE OF GROWTH OF DAIRY HEIFERS

In investigational work it is frequently found that a new unit of measurement, with which the results obtained can be compared, is necessary. In view of this fact it was deemed essential that curves for various forms of growth in calves be obtained. Such curves obtained from measurements of animals fed and grown out under normal conditions are extremely useful as bases with which to compare the growth of animals under experimental conditions. Little work of this character is at present available.

RÉSUMÉ OF PREVIOUS WORK

Practically the only work reported on the rates of growth of heifers is that by Eckles (7) who worked with Ayrshires, Holsteins and Jerseys and there the rate of growth to two years of age, when expressed as a percentage of the birth weights and measurements appears to be most rapid in the Jerseys with the Ayrshires second. This confirms general observations regarding the more rapid development of the smaller breeds of dairy cattle.

No effort will be made here to discuss the many factors which control growth but it may be noted that Waters (10) on feeding

calves from the time of birth on rations of various types, from scanty to full-fed, found that in the early stages of development growth in height was more rapid than growth in width. Later however, the growth in width tended to become more rapid. Eckles (6) confirms this observation that the growth impulse is decidedly stronger in the skeleton than in the fleshy parts of the body.

The results obtained by McCandlish (8) on feeding an unsuitable ration to young calves tend to give evidence in the same direction when the increases in live weight and body measurements are considered. The normal animals with which the abnormally fed individuals were compared showed the greatest percentage increase in live weight and then in the body measurements taken. The experimental animals showed greater percentage increases in live weight than in body measurements, but it was found that the decrease in percentage gain in live weight from the normal increase was greater than the average decrease in percentage gains in body measurements. To state it specifically, the percentage gain in live weight was only 30 per cent of normal, while the majority of the body dimensions increased at 50 per cent to 60 per cent of the normal rate. This would indicate that while under normal conditions gains in body weight are more rapid than body measurements, yet under adverse conditions the stimuli which cause increase in skeletal dimensions are not retarded so easily as are the stimuli which induce increases in live weight.

A factor of note in post-natal growth is the decrease in weight which is sometimes said to occur normally for some time after birth. Abnormal decreases are of course to be found in the case of many animals which are not properly nourished or are stunted in some way at that time. No reports of this character have been noted with calves. Robertson (9) however, has reported on the average loss of weight of South Australian infants during the first week after birth. He states that the post-natal loss of weight is due to the mechanical shock at birth, and to the nutritional changes taking place at that time. He finds that the average loss due to these factors is 9.2 per cent of the birth weight.

Post-natal loss is sometimes attributed to the fact that the young do not receive a sufficient supply of nutrients during the first few days after birth. This can hardly be looked on as the sole cause of the loss however, as there is post-natal loss in weight in guinea pigs, which have reached such a stage of development at birth that they can readily forage for themselves soon after that time.

EXPERIMENTAL WORK

The data reported here has been collected from a group of 40 heifers that have been raised from birth to producing age on the

TABLE 11

Change in weight of calves for ten days after birth

CALF NUMBER	SEX	AGE, DAYS									
		Birth	1	2	3	4	5	6	7	8	9	10
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
381	M	83	87	91	94	91	85	87	89	88	88	91
382	M	52	54	55	55	58	55	54	55	57	55	53
384	F	64	62	65	63	61	59	59	59	60	60	61
386	M	108	106	104	100	97	97	102	102	101	99	99
387	M	70	73	71	67	65	65	60	59	60	62	63
Average		77	80	80	79	78	76	76	76	77	76	77
Percentage of birth weight		100	104	104	103	103	99	99	99	100	99	100

Iowa State College Dairy Farm. These heifers are part of those discussed in section II of this series. The chief reason for obtaining the data was to have a growth curve to use as a basis with which the rates of growth of animals used in experimental work might be compared. The data was collected in the years 1916 to 1920 inclusive.

Purebreds and grades of the Guernsey, Jersey and Holstein breeds, and purebred Ayrshires were used in this work but so far no attempt has been made to arrive at breed characteristics, as the numbers of animals in the various groups at present would be too small for such purposes. The animals have been grouped however, according to the season of the year at which they were

dropped. Winter calves include those dropped from October 1 to March 31 and summer calves are those dropped from April 1 to September 30 inclusive. There are 24 heifers in the winter and 16 in the summer group. All of the heifers were reared under general herd conditions.

TABLE 12

Average live weights and body measurements of winter calves

AGE	LIVE WEIGHT	HEIGHT	DEPTH	WIDTH	PERCENTAGE INCREASE			
					Live weight	Height	Depth	Width
months	*pounds*	*inches*	*inches*	*inches*	*per cent*	*per cent*	*per cent*	*per cent*
Birth	68							
1	91	28.7	11.6	6.9	34			
2	120	30.7	12.6	7.5	76	7	8	9
3	163	32.9	14.2	8.5	140	11	22	23
4	210	34.8	15.4	9.4	209	21	33	36
5	262	36.4	16.7	10.2	285	27	44	48
6	317	38.4	17.9	11.0	366	34	54	59
7	373	39.8	18.7	11.8	449	39	61	71
8	424	41.0	19.7	12.8	524	43	70	86
9	467	42.2	20.3	13.4	587	47	75	94
10	500	42.9	20.9	13.8	635	49	80	100
11	533	43.7	21.5	14.2	684	51	85	106
12	569	44.5	22.0	14.8	737	55	90	114
13	604	45.1	22.6	15.3	788	57	95	122
14	644	45.7	22.8	15.6	847	59	97	126
15	680	46.1	23.4	15.9	900	60	102	130
16	708	46.5	23.8	16.3	941	62	105	136
17	729	46.9	24.0	16.5	972	63	107	139
18	750	47.3	24.2	16.7	1003	65	109	142
19	777	47.7	24.4	17.1	1043	66	110	148
20	806	47.9	24.8	17.5	1085	67	114	154
21	834	48.3	25.2	17.7	1126	68	117	157
22	861	48.5	25.4	17.9	1166	69	119	159
23	894	48.9	25.6	18.1	1215	70	121	162
24	922	48.9	25.8	18.5	1256	70	122	168
29	1010	49.4	26.4	19.5	1385	72	128	183

In addition to the general piece of work, consideration may be given here to results that were obtained on weighing a few calves daily for ten days after birth. In this limited test one heifer and four bull calves were used and the results obtained with them are tabulated.

The general scheme for obtaining body measurements and weights of the heifers used in the major portion of this work can be outlined shortly. Each heifer was weighed at birth. Then on the three consecutive days at the middle of each calendar month all the heifers were weighed and on one of these days the body measurements were taken. This method was pursued to avoid continuous weighing of the animals. The three consecutive weighings obtained were averaged and then the average of the first series and the average of the second series of weigh-

TABLE 13

Average live weights and body measurements of summer calves

AGE	LIVE WEIGHT	HEIGHT	DEPTH	WIDTH	PERCENTAGE INCREASE			
					Live weight	Height	Depth	Width
months	*pounds*	*inches*	*inches*	*inches*	*per cent*	*per cent*	*per cent*	*per cent*
Birth	64							
1	89	28.7	11.4	6.3	39			
2	119	30.7	12.8	7.3	86	7	12	16
3	163	32.7	14.4	8.3	155	14	26	32
4	212	34.6	15.7	9.4	231	21	38	49
5	262	36.4	16.9	10.2	309	27	48	62
6	309	38.2	17.9	11.4	383	33	57	81
7	355	39.8	18.7	11.8	455	39	64	87
8	396	40.8	19.5	12.4	519	42	71	97
9	429	41.8	20.1	13.0	570	46	76	106
10	464	42.5	20.7	13.4	625	48	82	113
11	504	43.3	21.3	14.0	688	51	87	122
12	540	43.9	21.7	14.4	744	53	90	129
13	576	44.5	22.2	14.8	800	55	95	135
14	607	44.9	22.6	15.3	848	56	98	143
15	629	45.3	23.0	15.4	883	58	102	144
16	651	45.9	33.2	15.7	917	60	104	149
17	676	46.5	23.6	15.9	956	62	107	152
18	698	46.9	24.0	16.3	991	63	111	159
19	720	47.3	24.2	16.5	1025	65	112	162
20	749	47.5	24.6	16.7	1070	66	116	165
21	782	47.7	24.6	17.1	1122	66	116	171
22	815	47.9	25.0	17.5	1173	67	119	178
23	844	48.3	25.4	17.5	1219	68	123	181
24	874	48.5	25.4	17.9	1266	69	123	184
29	941	49.2	26.2	18.9	1370	71	129	200

ings were averaged to obtain the weights of the animals at one month of age. This method was then followed through to the time of freshening. It is believed that it gives a reasonably true average as at the first weighing the animals would range up to

TABLE 14

Average live weights and body measurements of all calves

AGE	LIVE WEIGHT	HEIGHT	DEPTH	WIDTH	PERCENTAGE INCREASE			
					Live weight	Height	Depth	width
months	*pounds*	*inches*	*inches*	*inches*	*per cent*	*per cent*	*per cent*	*per cent*
Birth	67							
1	90	28.7	11.4	6.7	34			
2	120	30.7	12.8	7.5	79	7	11	12
3	163	32.9	14.2	8.5	143	15	25	27
4	211	34.8	15.4	9.4	216	21	35	40
5	262	36.4	16.7	10.2	291	27	47	52
6	314	38.4	17.9	11.2	369	34	57	67
7	366	39.8	18.7	11.8	446	39	64	76
8	413	41.0	19.5	12.6	516	43	71	88
9	452	42.0	20.3	13.2	575	46	78	97
10	486	42.7	20.9	13.6	625	49	83	103
11	521	43.5	21.5	14.2	677	52	89	112
12	557	44.3	21.9	14.6	731	54	92	118
13	592	44.9	22.4	15.1	784	56	96	125
14	628	45.5	22.8	15.4	837	59	100	130
15	659	45.9	23.2	15.7	884	60	104	134
16	685	46.3	23.6	16.1	922	61	107	140
17	708	46.7	23.8	16.3	957	63	109	143
18	729	47.1	24.2	16.5	988	64	112	146
19	754	47.5	24.4	16.9	1025	65	114	152
20	784	47.7	24.6	17.1	1070	66	116	155
21	813	48.1	25.0	17.3	1113	68	119	158
22	852	48.3	25.2	17.7	1171	68	121	164
23	874	48.5	25.4	18.1	1204	69	123	170
24	903	48.9	25.6	18.7	1248	70	125	179
29	982	49.4	26.4	19.3	1366	72	132	188

30 days of age and at the second from thirty to sixty days of age and the average of all would be thirty days of age.

The body measurements taken were the height at withers, depth of chest and width at hooks. These measurements were averaged in the same way as were the live weights. No measurements were taken at birth however.

DISCUSSION OF RESULTS

It will be noted in the tabulation that the live weights, starting at one month of age, are tabulated by months until the age of two years is reached. After that age the heifers were dropped from the work as they freshened and the live weights and body measurements are consequently omitted after that with the exception of the averages for the animals at the time of freshening. The average age of freshening was 29 months for each group.

TABLE 15

Ratio of average live weight of calves in pounds to product of average height, depth and width in inches

AGE	RATIO 1:	AGE	RATIO 1:
months		*months*	
1	24.5	14	25.4
2	24.6	15	25.4
3	24.4	16	25.7
4	23.9	17	25.6
5	23.7	18	25.9
6	24.5	19	26.0
7	23.9	20	25.6
8	24.4	21	25.6
9	24.9	22	25.3
10	24.9	23	25.5
11	25.9	24	25.9
12	25.4	29	25.6
13	25.7		

In surveying the results obtained on weighing calves daily for 10 days after birth it may be said that immediately after birth the calves appear to gain 4 per cent in live weight, probably due to intestinal fill and then gradually decrease until they have reached only 1 per cent below their birth weights and then come back to normal. These results do not indicate any marked changes in live weight immediately following birth, though there are greater changes in individual cases.

The winter calves averaged 68 pounds in live weight at birth, the summer calves, 64 pounds, and the total 67 pounds. This does not introduce any variation of importance.

There are variations from time to time in the rates of development of the two groups of heifers but at the age of two years the winter heifers exceed the summer heifers in all body measurements and in live weights, but have excelled the summer heifers in only one increase—the percentage increase in height. By the time the age of freshening is reached however, the winter heifers are excelled only in the percentage increase in depth of chest and width of hocks. The significance of this is probably not great, especially as the winter heifers were larger and heavier than the summer heifers at the time of freshening.

Formulae have at various times been presented for the calculation of the live weight of various classes of live stock from body dimensions. Without discussing the accuracy or practicability of such methods a table is presented here which shows that from the data obtained in this work, it was observed that there was a fairly constant relationship between the live weight in pounds and the product of the height, depth and width in inches. This ratio is approximately 1:25. It holds fairly well for the averages of the group but would vary considerably with individuals. There also appears to be a variation connected with the ages of the animals as with the younger animals the ratio tended to become narrower while it widened with the older individuals.

SUMMARY

From the data presented here a few facts appear to be in evidence.

1. There is apparently little indication of a post-natal loss in the weight of calves.

2. The live weight of the animals shows the most rapid increase.

3. When the body measurements taken are considered it is found that in rapidity of increase their rank from the highest to the lowest is width, depth and height.

4. Between winter and summer heifers there appears to be little difference except that the winter heifers reach a greater weight and greater body measurements by the time of freshening than do the summer heifers.

5. There appears to be a fairly definite ratio between the live weight of the animals in pounds and the product of the height, depth and width in inches.

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REVIEW OF FOREIGN DAIRY LITERATURE

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INTRODUCTION

In my survey of French dairy literature, I shall attempt to bring before the readers of the JOURNAL, the current thought of French dairy interests both from the scientific and practical standpoints by means of abstracts of articles as they appear in French publications. At times I shall offer complete translations if they seem to be of particular interest, to a large group or, if an especially good piece of work is published.

The following papers among others will be reviewed:

1. *Le Lait*, a general review of matters pertaining to the dairy industry, published monthly at Lyon.
2. *La Laiterie*, a paper published semi-monthly in Paris devoted to the interests of the dairy farmer and creameryman.
3. *Lacta*, a world wide review of the dairy industry published in Paris.
4. *L'industrie Laitiere*, official bulletin of the French Society for the encouragement of the dairy industry.

I shall be glad at any time to cover subject matter that may be suggested by the reader.

DRUGE, F., Chemist of the Maison, Lefevre, Utile at Nantes. Two short investigations on milk. *Le Lait*, 2nd year, February, 1922, no. 2.

Influence of Chloroform and of toluene on the activity of rennet

The milk used in the experiment was fresh mornings milk. It was immediately distributed in three Erlenmeyer flasks marked with the letters A, C, and T.

Bottle A contained pure milk.

Bottle C chloroform added at the rate of 14 grams per liter.

Bottle T toluene added in the same proportions, 14 grams per liter.

The initial acidity of the milk was equal to 155 cc. of soda $\frac{N}{10}$ per liter equivalent to 1.39 of lactic acid.

Each of the flasks was then rapidly raised to a temperature of 35° and one milligram of rennet for each 100 cc. of milk added. The temperature was maintained at 34–35° until the end of the experiment.

The rapidity of coagulation shows the following:

Bottle A, coagulation complete and firm in 87 minutes.[1]

Bottle C, coagulation complete and firm in 122 minutes.[1]

Bottle T, coagulation complete and firm in 92 minutes.[1]

Chloroform retards the activity of rennet to a considerable extent; toluene has an insignificant effect.

Influence of chloroform and of toluene on the spontaneous coagulation of cow's milk

This experiment has been carried on under the same conditions as in experiment I. The bottles have however been doubled, i.e., we had two series of flasks A, C, and T.

The first series was left at laboratory temperature about 18°C. The second was put in a cold cellar at 50°C.

The initial acidity, titrated according to the usual procedure, was practically 1.39 lactic acid per liter. The following results were obtained.

		AFTER 24 HOURS	AFTER 24 HOURS	AFTER 48 HOURS	AFTER 72 HOURS	AFTER 96 HOURS	AFTER 120 HOURS
		grams	grams	grams	grams	grams	grams
Bottle A	+18°C....	1.48	1.495	5.85 Coagulated	7.85 Coagulated	5.13 In filtered serum	
	+5°C....		1.39	1.39	1.39	1.39	1.59
Bottle C	+18°C....	1.44	1.44	1.44	2.11	4.96 In filtered serum	
	+5°C....		1.39	1.39	1.39	1.39	1.39
Bottle T	+18°C....	1.44	1.44	1.44	4.95 Coagulated	4.95 In filtered serum	
	+5°C....		1.39	1.39	1.39	1.39	1.57

[1] Lactic acid per liter of serum resulting from the filtration of the coagulated milk: Ogr. 90.

The inhibiting action of chloroform on the lactic ferments is now unquestionable; that of toluene is much more feeble. In combining the action of low temperature and that of chloroform, milk may be preserved for five days without its acidity increasing, a great advantage in certain kinds of investigation.

BLIN, HENRI, Laureat de l'Academic d'Agriculture. Cooperative creameries in Brittany. *La Laiterie*, January 21, 1922, vol. 28, no. 2.

Brittany with its temperate climate, pastures, and its facilities for export of butter to England, a great consuming country, offers outstanding advantages for dairy development. M. Blin says there is a great opportunity for the development of the butter industry in this northwestern section of France. He points out that Denmark, hardly as large as Brittany and Normandy combined, with its small farms by means of cooperative organization, has been able to hold first place on the English market. Specialization has made the Danes watch closely the functioning of their coöperatives to keep down the cost of production. The sale of their products is a vital necessity, so that they manufacture on a large scale a product of a superior quality.

Denmark has more than 1500 dairy coöperatives with more than 150,000 members exporting to England 90,000 metric tons, while France ships hardly 20,000 (pre-war figure). Ireland has federations organized on coöperative principles while Germany has several thousand. In France there were before the war, 106 coöperative dairies in Charentes and Poitou with 60,000 members making 8,000,000 kgm. of butter annually, valued at nearly 12,000,000 francs.

The writer points out that there is no reason why Brittany should not follow this progressive movement and that it will be a great day for the industry when the Briton farmers have been convinced of the advantages of cooperation. Private capital shows itself capable of operating creameries on a large scale. M. Blin believes it just as easy for farmers to operate creameries coöperatively if they will only analyze the situation more closely and work together with the proper spirit. He shows that private enterprise at the present time is taking advantage of the unorganized French farmer and that it is time for concerted action.

He reviews the production of the different provinces as reported in 1914. In la Loire-Inferieure there were 182,956 dairy cows producing 1,452,132 hectoliters of milk. The production of butter approximated

400,000 kilos annually. In the department or province of Ille et Vilaine, which ranks first as a province in the production of milk, there were 433,000 cows producing 4,521,347 hectoliters of milk. Finistére with 260,000 cows produced 1,408,500 hectoliters of milk and 312,130 kgm. of butter were made. Morbihan with 212,421 cows produced 2,727,984 hectoliters of milk. Côtes-du Nord which ranks fourth in production of milk in France has a cow population about equal to Morbihan and produces 3,000,000 hectoliters of milk. In Ille and Vilaine there are some commercial creameries and a few in Côtes-du-Nord. However the coöperative creamery is practically unknown except for a little development in Morbihan.

M. Blin emphasizes the advantages of the coöperative creamery. They are able to reduce the cost of making and to make a standardized product of superior quality. Further, the use of centrifugal separators means greater efficiency in the removal of fat from the milk. The French farmers suffer great losses every year by the use of the shallow pan method of skimming.

The organization of the coöperative creamery calls for a capitalization of from 40–50,000 francs of which 20–22,000 francs is required for equipment. There must be 200 to 250 members or patrons frunishing 200 francs besides being able to supply a total of 4–6000 liters of milk daily. M. Blin shows how the financing may be taken care of by brokerage on the milk consigned by each patron. In conclusion he says: "There is a place in Brittany for coöperative creameries, assuring a large remuneration for the efforts expended and the capital invested. Rural economy, in this country, ought to find a productive source of the most happy results for the small producers in the exploitation of the industrial creamery under the guarantee of the coöperative organization."

S. H. H.

Lucas, J. E. And Leroy André. The Food Value of Milk with Reference to its Sale Price. *Le Lait*, 2nd year, January, 1922, no. 1.

The problem of supplying milk to the centres of large population in France has for several years with the beginning of each winter, become more momentous. Lucas and Leroy point out that such a situation is prejudicial to the public health since milk is an ideal food for children, the sick, the aged and as well for adults; that it deserves a more important place than that which it occupies because of its high nutritive

value and its desirable physiological effects on the human body. Civil authorities and children's aid societies have interested themselves in this serious question to find out the causes and remedies.

In spite of the rise in price of milk during the war to 1 franc 10 centimes (normal exchange 22 cents) it is with the greatest difficulty that people in Paris and its suburbs supply themselves with milk especially in the winter season. The normal price of milk for the winter of 1913 was 40 centimes (8 cents). In 1914 the daily rail shipments of milk into Paris amounted to 900,000 litres while those of 1919 reached barely 560,000 litres and that to supply a population increased by 350,000.

The writers say this shortage of milk is due to such things as the cost of raising dairy cows, the difficulty of procuring capable help, market price of hay with plenty of demand for it, the ready market for butter and cheese, and lastly, unjustifiable legal suits against dairymen.

It requires about 9 francs per day to feed a cow in the vicinity of Paris, this figure including feed costs, labor, interest on investment and the items of so-called indirect or overhead expense. This makes a farm cost of 90 centimes per litre. Add to this transportation, distribution, and plant charges and there is no margin of profit left even with milk selling at 1 franc 10 centimes. This they say would discourage production.

Further the authors point out that it is hard to get help on dairy farms because of the long hours. "The painful conditions of his (the herdsman) existence are not in harmony with the desires for gain and of easy life which are getting into the rural masses."

The price offered for straw and hay on the large city and country markets is high enough to discourage its being fed to milch cows. Further milk has been severely taxed while butter and cheese have not. The farmer at a distance from a large city has found it more advantageous to manufacture his milk into cheese or butter, keeping the skimmilk and buttermilk on the farm for feeding pigs.

Legislative acts have prevented in many places the rise in price of milk to meet the cost of production. As a result, a great many dairymen have been driven out of business. In conclusion, Lucos and Leroy believe that the principal reason for the milk crisis has been the suppression by acts of the government of the normal functioning of the law of supply and demand so that the price of milk has not kept pace with the cost of production and its food value.

In a table presented, the food value of milk is compared with that of meats, vegetables, eggs, chocolate, etc. The superior value of the amino acids in milk is discussed as compared with those of other foods. "The vitamines, or accessory factors of growth have an unknown chemical nature which exists in the majority of our foods and whose presence in our rations is indispensable to the best condition of the body." Milk is emphasized as a protective food from the health standpoint containing food elements necessary to maximum growth and the most healthy condition of the body. Further they point out that from the energy standpoint alone that "in the many modest budgets notable economies could be realized by replacing a certain portion of the meat in the ration by an isodynamic quantity of milk or milk products."

The problem in France, particularly in the large cities, is to obtain a larger milk supply. Lucas and Leroy conclude "that it is only by an increase in milk production on the farms that a satisfactory supply in the large cities will be insured. Good measures will be those which stimulate the stockmen permitting them to realize the maximum of profit. It is by the return to normal functioning of economic laws, by the total suppression of taxation, that a return to normal will be obtained, that is to say, a sufficient market supply. Complete liberty must be returned to the milk business and a higher price paid for its product for some time."

Comment. France has been suffering from a shortage of milk during and since the war period and the supply is not getting back to normal. Health authorities see that it is a health problem and are trying to foster measures that will stimulate its production. Dairy farmers in France seem to have their troubles as well as in America, though perhaps from a slightly different viewpoint.

S. H. H.

BOOK REVIEW

The Marketing of Whole Milk by Henry E. Erdman is a recent addition to the Citizens Library of Economics, Politics and Sociology, edited by Dr. Richard Ely and published by the MacMillan Company.

After an introductory chapter, the presentation is organized around the headings of milk as a community commodity, the market for whole milk, distribution of milk, collective bargaining in the sale of whole milk, milk prices, consideration of proposed remedies, and conclusions.

Dr. Erdman approaches the milk problem primarily from the standpoint of the economist but his presentation makes evident an intimate and sympathetic acquaintance with the complex details of the business. He appreciates the desirability of grades of milk and the necessity of standardization in connection with buying milk on the basis of its food value. The place of the middleman is pointed out, the limitations of centralization of milk companies are noted and the question of duplication in milk delivery is well presented.

The handling of the various economic aspects of the milk question is particularly good.

Taken all in all this is perhaps the simplest and clearest available presentation of the manifold problems of the city milk business. The form of presentation, while concise, will appeal to the layman as well as to the student of the subject. There is a good table of contents and subject index and the mechanical work is up to the high standard of the publishers.

H. A. H.

ANNOUNCEMENTS

FOREIGN DAIRY LITERATURE. Beginning with this issue of the JOURNAL OF DAIRY SCIENCE, the first effort is made to give reviews and abstracts of dairy literature appearing in foreign publications. Prof. S. H. Harvey of College Park, Maryland, has generously volunteered to review and abstract dairy journals, bulletins and other French publications of interest to our readers. Plans are being developed for the regular abstracting of dairy literature from other foreign countries. This, of course, is a big task and can only be accomplished by having the hearty coöperation of all members of the American Dairy Science Association qualified for this work. We hope that you will volunteer service in this connection and that you will give us your suggestions regarding other persons particularly qualified for this kind of work.

NEWS NOTES. Many of the readers of the JOURNAL are particularly interested in news items such as have been running from time to time under the heading "Dairy Notes." This department can be kept up only if each member will coöperate by sending in such news items as come to his attention. Please feel free to send such items to any member of the editorial board, but preferably to Secretary J. B. Fitch.

CONDENSE YOUR PAPERS. During the last few months there has been a remarkable increase in the number of papers submitted for publication in the JOURNAL OF DAIRY SCIENCE. This of course means that on account of the limited size of the JOURNAL, some authors have been disappointed. The problem of how to provide space for all worthy papers can be solved at least in part, if each author will cooperate by condensing his paper as much as he possibly can without sacrificing any of the essential features of his message. Your hearty coöperation in this matter is earnestly solicited.—J. H. FRANDSEN, *Editor*.

DAIRY NOTES

The Dairy Division of the United States Department of Agriculture reports the following resignation:

E. V. Ellington, after approximately eight years of service in the Dairy Division, B. A. I., resigned on March 6 to accept the position of professor of dairying at Washington State College and head of the dairy division of the experiment station at Pullman, Wash. His successor has not been selected. He was formerly acting in charge of the Dairy Extension Section, in which capacity he directed extension work with cow-testing and bull associations, cheese manufacturing, and general dairy farming, and was recently made associate in charge of dairy introduction work.

The following changes are reported by the Dairy Department of the Connecticut Agricultural College at Storrs, Connecticut:

Prof. P. A. Campbell, who has been extension dairyman for two years, has left the department to take charge of a large dairy farm near Philadelphia, Pa. *Mr. A. H. Merrill*, who succeeds Mr. Campbell, has for the last two years been manager of a large stock farm at Dixville Notch, N. H. He previously had taught dairying in two of the leading secondary schools of agriculture in this part of the country. He is a graduate of the New Hampshire State College.

Mr. J. A. Simms, who has been in general live stock work other than dairy cattle with the extension service, has been appointed as an assistant to Professor Merrill. Mr. Simms is a graduate of North Carolina Agricultural College.

Washington State College at Pullman, Wash., reports the resignation of *E. G. Woodward* as head of the dairy department. Mr. Woodward resigned to go into commercial work.

THE CULTURE COLLECTION OF THE SOCIETY OF AMERICAN BACTERIOLOGISTS

The Society of American Bacteriologists has taken over the collection of cultures which for the past ten years has been maintained at the American Museum of Natural History by Prof. C.-E. A. Winslow,

and has deposited it at the Army Medical Museum, where facilities have been arranged for its housing and maintenance.

The following committee will be in charge:

Major G. R. Callender, Curator of the Army Medical Museum
Dr. Geo. W. McCoy, Director Hygienic Laboratory, U. S. Public Health Service
Major H. J. Nichols, Army Medical School
The President of the Society
The Secretary of the Society
Dr. J. M. Sherman, Dairy Division, Bureau of Animal Industry, Chairman

These and other members of the Society in and near Washington will do volunteer work and the Research Fellow will do part time work in maintaining the collection. No charge will be made for cultures. In making requests, the classification of the Society should be followed as far as possible.

Mail should be addressed to the Department of Bacteriology, Army Medical Museum, 7th and B Streets, S. W., Washington, D. C.

J. M. SHERMAN,
Chairman of the Committee.

A RESEARCH FELLOWSHIP IN BACTERIOLOGY

It is announced by Dr. Victor C. Vaughan of the National Research council in Washington, that the Society of American Bacteriologists at its recent meeting in Philadelphia, appropriated a fund for the support of a Research Fellowship in pure bacteriology. While excellent work is being carried on in many places, nearly all the problems under investigation have as their aim a practical application and there are, therefore, many gaps in our knowledge of fundamental principles. The Society, believing it to be the duty of bacteriologists to fill these *lacunae* requires that the line of work to be carried on under its fund must concern a purely scientific and fundamental phase of bacteriology, although a certain latitude of choice will be permitted, conditioned by the previous training and the desires of the Research Fellow himself.

Applicants for the fellowship must have the degree of B.S., or its equivalent. The successful candidate, through arrangements now being made, will receive academic credit for the work done from a university of recognized standing. One hundred dollars a month will be available for the living expenses of the fellow. Approximately half his time will be devoted to details connected with the Society's collection of bacteria, deposited at the Army Medical Museum.

The selection of the Research Fellow will be in charge of a committee consisting of:

Dr. Victor C. Vaughan, Chairman Medical Section, National Research Council; Chairman
Captain C. S. Butler, Medical Corps, U. S. Navy, Commandant, Naval Medical School
Dr. Geo. W. McCoy, Director Hygienic Laboratory, U. S. Public Health Service
Dr. John R. Mohler, Chief, Bureau of Animal Industry
Mr. L. A. Rogers, (President of the Society of American Bacteriologists) In Charge of Research Laboratory, Dairy Division, Bureau of Animal Industry
Colonel Joseph F. Siler, Medical Corps, U. S. Army, Division of Sanitation, Office of the Surgeon General of the Army
Dr. Erwin F. Smith, Pathologist in Charge, Laboratory of Plant Pathology, Bureau of Plant Pathology

This committee will have general supervision of the work, approve the problem selected and pass upon the thesis which the fellow will submit as the report of his research.

Applications for and communications concerning the Research Fellowship should be addressed to the Chairman of the Committee, Dr. Victor C. Vaughan, National Research Council, Washington, D. C.

A. PARKER HITCHENS, Major, M. C.
Secretary of the Committee.

Army Medical School,
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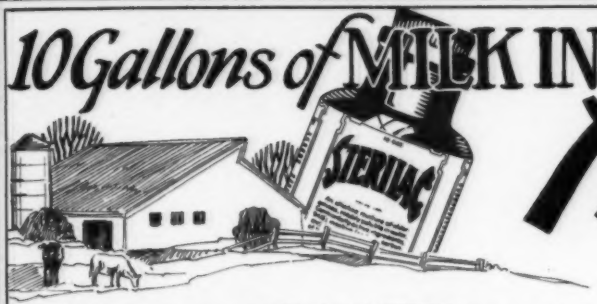

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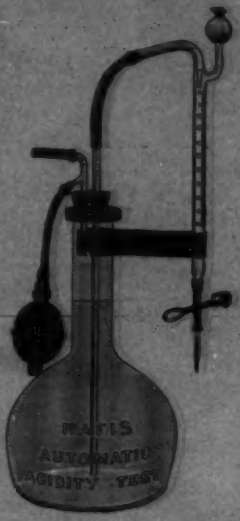

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